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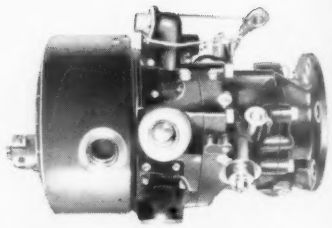
AERONAUTICAL ENGINEERING REVIEW

MARCH 1953

AIR SAFETY ISSUE

The Grumman F9F-6 COUGAR is the Navy's latest addition to its carrier-based combat force. Rated for security reasons in the "over 600 MPH" class, the swept wing COUGAR is the successor to the battle-proved Grumman PANTHER.

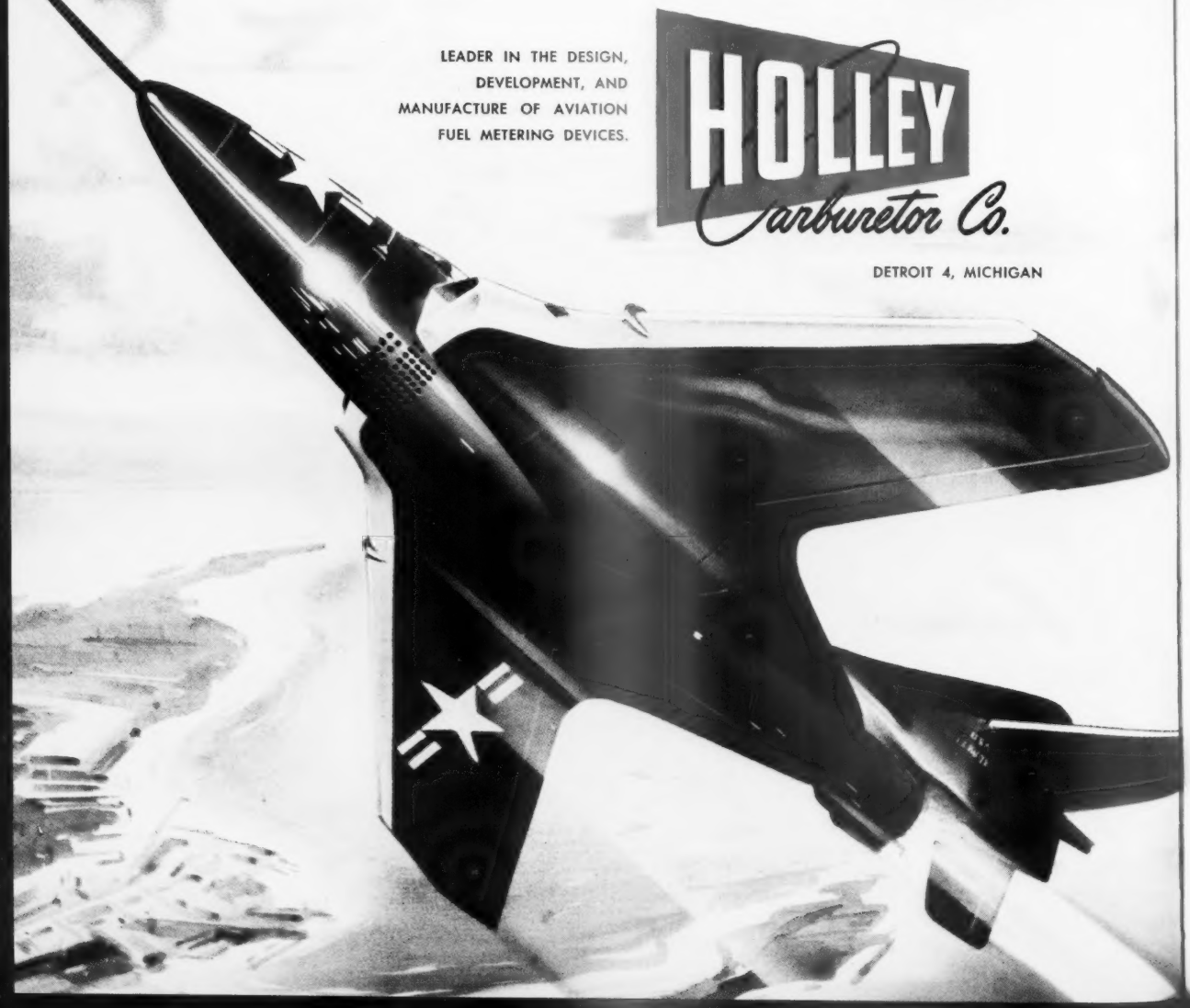
The complex turbine control needed to regulate the COUGAR'S powerful Pratt and Whitney J-48 jet engine is designed, engineered and manufactured by Holley.



LEADER IN THE DESIGN, DEVELOPMENT, AND MANUFACTURE OF AVIATION FUEL METERING DEVICES.

HOLLEY
Carburetor Co.

DETROIT 4, MICHIGAN



Cover—The Cessna Aircraft Company's new model 310 Businessliner, powered with two 225-hp. Continental engines, made its first flight on January 3, 1953. Cessna officials at present expect that line production on this five-place commercial-private airplane will begin early in 1954. The 310 features, in addition to the wing-tip tanks, a retractable landing gear, a semimonocoque engine mounting, and an internal radio antenna. Its overall length is 27 ft., 1 in.; the wing span, including wing-tip tanks, is 36 ft., 1 in.; and the height is 10 ft., 2 in. in the three-point position. With the tail depressed, the height of the 310 measures 7 ft., 6 in.

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AERONAUTICAL ENGINEERING REVIEW

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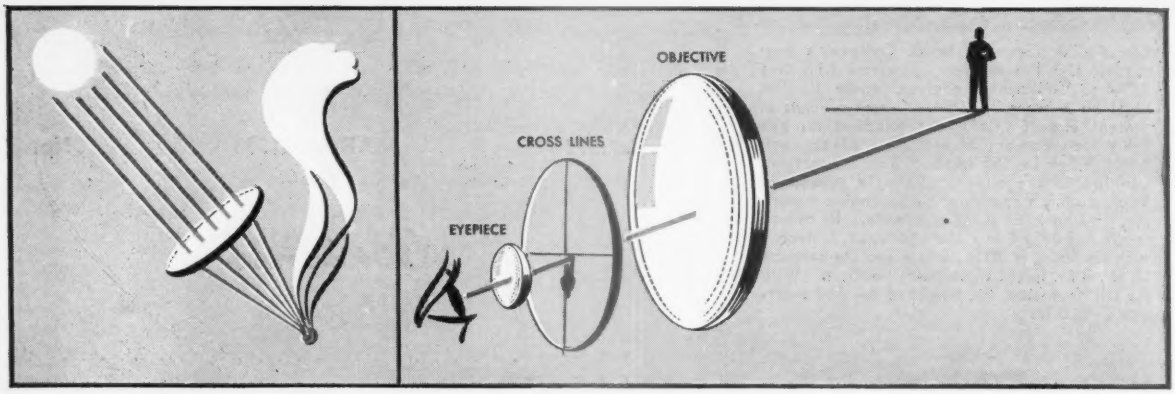
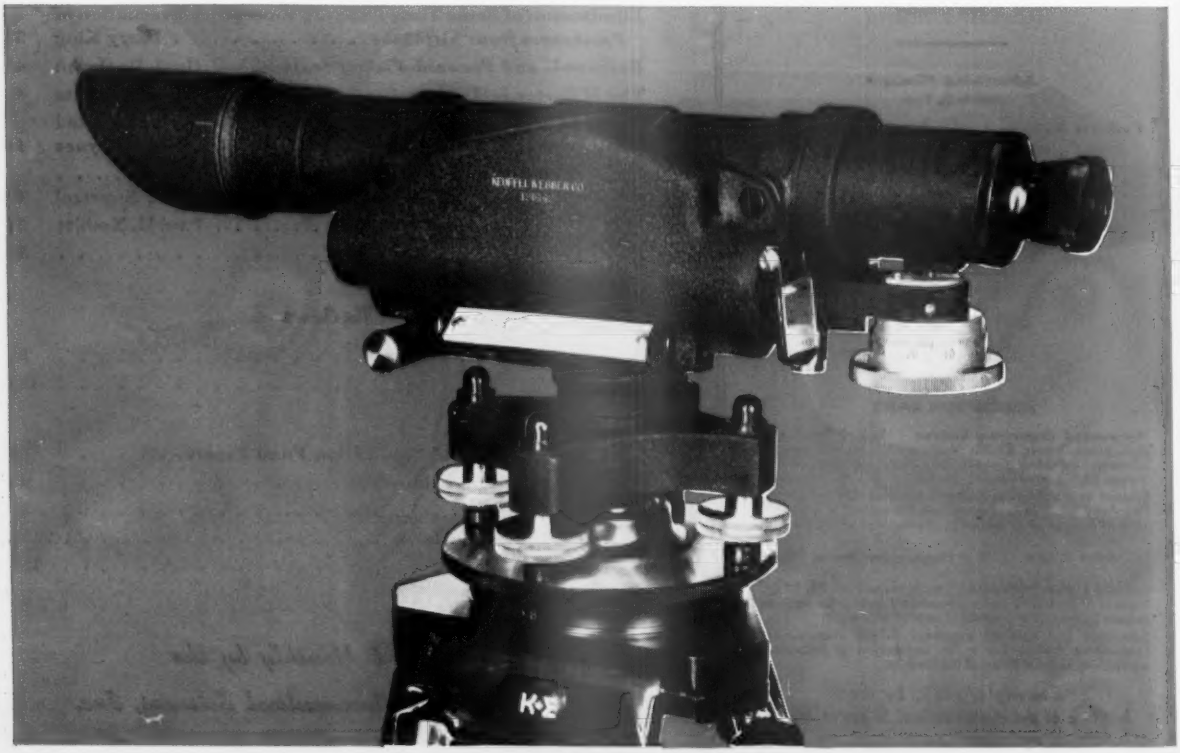


Even an ordinary reading glass can produce an image of sorts. That happens when the sun's rays are focused on a piece of paper as shown. All the rays passing through the lens concentrate at approximately one point where they form a small inverted picture or image of the sun.

By means of a lens, rays from any object at a distance can be made to concentrate inside a telescope in the same way. They form a tiny inverted picture of the object. If a screen like the ground glass of a camera were placed there and viewed through a magnifying glass, the actual picture of the distant object could be seen clearly. The lens that brings the tiny picture into a telescope is called the objective, and the small but powerful microscope that brings it out of the telescope into the eye is called the eyepiece.



I.A.S. News Notes

March 1953

DR. THEODORE VON KARMAN TO LECTURE

The Department of Aeronautical Engineering of Princeton University announces that Professor Theodore von Karman, world-famous aerodynamicist, is scheduled to deliver three guest lectures on the subject, "Aerothermodynamics and Combustion Theory", on Monday, Wednesday, and Friday, March 23, 25, and 27, at 3:00 p.m. The Daniel and Florence Guggenheim Jet Propulsion Center at Princeton is sponsoring the lecture. A general invitation to attend is being extended to those outside of Princeton University who are interested in scientific aspects of combustion phenomena.

* * * * *

PROCEEDINGS OF SECOND CONVERTIBLE AIRCRAFT CONGRESS NOW AVAILABLE

A 140-page book, containing the 15 papers, speeches, etc., presented at the Convertible Aircraft Congress in Philadelphia, December 12, 1952, is now being published by the Institute. Copies may be obtained from I.A.S. headquarters at $3.00 each for members of the Institute and the American Helicopter Society; $5.00 to nonmembers, after March 15.

* * * * *

NEW I.A.S. CORPORATE MEMBER

J. B. Rea Company, Inc., West Los Angeles, California

* * * * *

APRIL REVIEW FEATURES

The April Review covers the highlights of the Honors Night Dinner, Awards, etc., including the full text of Gen. Vandenberg's address. A splendid synopsis of the Annual Meeting technical sessions is presented through the individual reports of session chairmen. Aviation Medicine is featured in this issue. Eight papers, dealing with the various aspects of this important subject, are published in full.

* * * * *

CALENDAR OF I.A.S. NATIONAL MEETINGS

March	13	Annual Flight Propulsion Meeting, Carter Hotel, Cleveland, Ohio
May	20-22	I.A.S., A.I.E.E., and I.S.A. Joint International Telemetering Conference, Edgewater Beach Hotel, Chicago, Illinois
July	15-16	Annual Summer Meeting and Honors Dinner, Los Angeles, California
Sept.	7-17	Fourth International Aeronautical Conference, London, England

* * * * *

I.A.S. News Notes (con't.)

CALENDAR OF SECTION MEETINGS

March 3---Washington Section: Natural History Museum, 8:00 p.m. Dr. Alex Lippisch, Collins Radio Co.,and Mr. J.S.Attinello, BuAer, Research & Development Division,to speak on Advanced-Practical Aerodynamics.

March 4---Wichita Section: Location not known at press time."Practical Aspects of High Speed Wind Tunnel Testing" by Alan Pope, Chief of Aerodynamics, Sandia Corporation.

March 4---Philadelphia Section: Engineers Club, Dinner, 7:00 p.m.; Meeting, 8:00 p.m. "Flying Conditions in Europe Today" by Lt. Colonel Alfred L.Wolf, USAF Reserve.

March 6---Texas Section: Midway Inn, "The Aero Design Company and Their Aero Commander" by T. R. Smith, Vice-President of Engineering and Manufacturing, Aero Design Company.

March 11---Buffalo Section: Touraine Hotel, Social Hour, 7:30 p.m.; Meeting, 8:00 p.m. (RESTRICTED MEETING). "Design Features of the X-5 Airplane" by James A. O'Malley, Project Aerodynamicist, Bell Aircraft Corporation.

March 12---Detroit Section: International Institute, 8:00 p.m. "Commercial Jet Transports" by Charles Froesch, Vice-President--Engineering, Eastern Air Lines. (Joint meeting with Aero Club of Michigan).

March 12---Los Angeles Section: I.A.S. Building, 8:00 p.m. Specialist Meeting on Improvement of Laminated Transparent Plastics for Aircraft Glazing. Speaker, Dr. Johan Bjorksten, President of Bjorksten Research Laboratories.

March 12---Chicago Section: Museum of Science & Industry, Dinner, 6:30 p.m.; Meeting, 7:30 p.m. Air Force and Industry personnel to speak on Design Trends of Modern Aircraft."

March 12---San Diego Section: Dinner Meeting; I.A.S.Building, 7:00 p.m."Cross Country Soaring" by W.S.Ivans. (Joint meeting with the Associated Glider Clubs of Southern California.)

March 13---Cleveland-Akron Section: (See Calendar of I.A.S.National Meetings)

March 19---Toronto Section: Mechanical Engineering Building, University of Toronto, Room 102, 8:15 p.m. "Current Trends in Design of Airline Transports" by Mr. J. T. Dyment, Director of Engineering, Trans Canada Airlines. (Joint meeting with Toronto Branch of Engineering Institute of Canada).

March 19---Los Angeles Section: I.A.S.Building, Social Hour,5:30 p.m.; Dinner, 6:30 p.m.; Meeting, 8:00 p.m. "Are We Headed in the Right Direction" by William B. Stout, Research Consultant.

March 26---Los Angeles Section: I.A.S. Building, 8:00 p.m. Specialist Meeting on "Some Basic Concepts for Analyzing Dynamic Flight Test Data". Speakers, Harold Klein and Raymond Sedney,Douglas Aircraft Co., Inc.

April 1---Wichita Section: Location not known at press time. "Helicopters in Korea" by Tom Harriman, Assistant Chief Engineer, Bell Aircraft Co.

April 3---Los Angeles Section: I.A.S. Building. Symposium on "Frontiers of Man-controlled Flight". (Co-sponsored with Institute of Transportation and Traffic Engineering of UCLA and presented by the Aeromedical-Engineering Association).

April 9---Los Angeles Section: I.A.S.Building, 8:00 p.m. Specialist Meeting on "Ram-Air Turbine Driven Auxiliary Power Units for Missiles". Speaker, Edward I. Brown, Marquardt Aircraft Company.

* * * * *

I. A. S. News

A Record of People and Events of Interest to Institute Members

Annual Business Meeting of the Institute

Reports of President, Treasurer, and Director

THE TWENTY-FIRST ANNUAL MEETING of the members of the Institute was held at the Hotel Astor, New York, on January 28, 1953. The President, Wellwood E. Beall, presided.

Daniel Sayre, Teller, reported that he had received and counted 1,005 valid proxies for voting at the Annual Meeting—a quorum of the voting membership.

The Secretary reported that he had received a letter from Dr. H. L. Dryden, Chairman of the Nominating Committee, stating that he would be unable to attend the meeting and requesting that the following members be placed in nomination for election to vacancies on the Council: Charles J. McCarthy, George W. Brady, C. L. Johnson, J. S. McDonnell, Ernest G. Stout, and Preston R. Bassett for a term of 1 year each; W. B. Bergen, A. E. Raymond, L. B. Richardson, P. B. Taylor, and T. P. Wright for a term of 3 years each; and the following area councilors for a term of 1 year each: Eastern Area—Harris S. Campbell and Charles F. Savage; Central Area—Frank R. Cook and C. J. Gallant; Western Area—F. A. Cleveland and J. R. MacGregor. On motion duly made, seconded, and carried, they were unanimously elected. The following were nominated and elected in like manner to serve on the Nominating Committee for 1953: L. B. Richardson, Chairman, Wellwood E. Beall, F. W. Caldwell, Luis de Florez, James H. Doolittle, Charles Froesch, John C. Leslie, and A. E. Raymond.

The Annual Reports of the President, Treasurer, and Director were read and approved. (See the following pages for the complete reports.)

The Secretary presented a list of honors conferred by the Institute in 1953 as follows:

The Thurman H. Bane Award presented posthumously to Major Patrick L. Kelly "for developing techniques providing for artificial stability and control of aircraft during high-performance phases of operation"; and presented to Henry Seeler, Aero Medical Laboratory, Wright Air Development Center, Wright-Patterson Air Force Base, "for developing and standardizing a resuscitator, capable of operating at varying altitudes, for use in combat or evacuation aircraft." The Octave Chanute Award to John Clifford Seal, Chief Research Pilot, Flight Research Department, Cornell Aeronautical Laboratory, Inc., "for developing precise piloting techniques, making possible fundamental research in full-scale dynamic stability and control, flutter, and structural loads determination." The John Jeffries Award to Lt. Col. John P. Stapp, U.S.A.F. (M.C.), Chief, Special Projects Unit, Biophysics Branch, Aero Medical Laboratory, Research Division, Wright Air Development Center, Wright-Patterson Air Force Base, "for outstanding contributions to the advancement of aeronautics through medical research." The Robert M. Losey Award to Vincent J. Schaefer, Scientist, Research Laboratory, General Electric Company, and Consultant, "in recognition of outstanding contributions to the science of meteorology as applied to aeronautics." The Sylvanus Albert Reed Award to John Stack, Assistant Director, Langley Aeronautical Laboratory, N.A.C.A., "for his leadership in the design, development, and practical operation of transonic wind tunnels." The Lawrence Sperry Award to Dean R. Chapman, Aeronautical Research Scientist, Ames Aeronautical Laboratory, N.A.C.A., and Lecturer in Graduate Mechanical Engineering at Stanford University, "for contributions to the basic knowledge of skin friction, base pressure, and heat transfer at supersonic speeds." The Wright Brothers Lecturer, William Littlewood, Vice-President—Engineering, American Airlines, Inc.

Honorary Fellowships in the Institute to: American—James Howard (Dutch) Kindelberger, Chairman of the Board and Chief Executive Officer of North American Aviation, Inc.; Foreign—Charles Clement Walker, Chief Engineer and a Founder Director of the de Havilland Aircraft Company, Ltd., of England.

Fellowships in the Institute to: Carlton Bioletti, Assistant Director, Ames Aeronautical Laboratory, N.A.C.A.; Philip A. Colman, Division Engineer, Aerodynamics, Lockheed Aircraft Corporation; G. H. Dowty, Chairman and Managing Director, Dowty Equipment Ltd., and President (1952–1953) of The Royal Aeronautical Society, Great Britain; Louis G. Dunn, Director, Jet Propulsion Laboratory, California Institute of Technology; Frank W. Fink, Chief Engineer, Consolidated Vultee Aircraft Corporation; Capt. John J. Ide, U.S.N.R., Aeronautical Consultant, N.A.C.A.; Peter Masefield, Chief Executive, British European Airways, Great Britain; Frank N. Piasecki, Chairman of the Board, Piasecki Helicopter Corporation.

The Secretary announced that the Council had elected the following officers of the Institute for 1953: President Charles J. McCarthy; Vice-Presidents, George W. Brady, C. L. Johnson, J. S. McDonnell, and Ernest G. Stout; Director, S. Paul Johnston; Treasurer, Preston R. Bassett; Secretary, Robert R. Dexter, and Controller, Joseph J. Maitan.

ROBERT R. DEXTER
Secretary

President's Report—1952

THE LONG-TERM PROGRAM of the Institute—that of fostering the advancement of aeronautics—again gained ground during the past year. A new awareness of our responsibility to the nation and its national defense industries was, of course, only natural, world conditions being as they are.

The improvement of our engineering capabilities, in light of an increasing complexity in modern aircraft, has become a "must" for all engineers. Just as the day has passed when one man truthfully could say, "I designed that airplane," so is passing the day when an engineer can say, "I am an aeronautical engineer." Such a title can mean almost any one of hundreds of specialties. We already have subspecialists in this field of aeronautics. This profession of ours is becoming increasingly specialized, and I believe the Institute can do a great deal to keep us all on an "even keel" as it were. In all specialization there is a definite tendency to ignore, often of necessity, other important aspects of the profession. The Institute, through its excellent technical publications and meetings, assists us all in keeping abreast of at least the rudiments of other phases of the profession.

I also believe that one of our most important accomplishments during 1952 was the compilation of a rather complete VOCATIONAL GUIDANCE MANUAL. It will, we hope, serve a good and worthwhile purpose in providing vocational advisers at all levels with useful material concerning the engineering opportunities in aviation. It is designed to be just what its title indicates...."A Guide to the Engineering Professions in the Aviation Industries."

A considerable amount of work has gone into this brochure, and more than 25,000 are being distributed. Distribution primarily has been made to engineering schools, vocational counselers throughout the nation, and other likely users.

The brochure, like many of the other I.A.S. activities for 1952, fits in closely with the avowed purpose of the Institute so ably described last year by Admiral Richardson. He said—and I paraphrase—The value of scientific and engineering societies tends to increase during times of crisis...their value to the defense effort is beyond question.

Our various meetings and conferences during 1952 again were designed toward this same objective. There is no doubt in my mind that the year-by-year activities of the Institute have contributed largely to the present high state of the art in this country.

In our search for *quantity* we must not, however, neglect the even more important aspect of *quality* in our engineers. This is a tough business we are in, and a professional man must keep up to date on his specialty if he is to succeed.

Highly successful technical meetings were held this past year at Los Angeles, New York, Cleveland, and elsewhere. Attendance was at an all-time high. Total membership of the Institute also has reached the record number of over 9,000. The joint Royal Aeronautical Society-I.A.S. meetings have helped greatly to give us world stature, and another such meeting is planned for this year.

The members of the Council of the Institute have continued to do an outstanding job. Our permanent staff members, under S. Paul Johnston, continued in the finest tradition to handle the affairs of the Institute and to work toward even higher goals.

I should like to offer my sincere thanks to the Council, Officers, the Director, and our members throughout the world for helping to make this a most successful year for the I.A.S.

WELLWOOD E. BEALL
President, 1952

Treasurer's Report

YOUR SOCIETY'S BALANCE SHEET and operations for the year ended September 30, 1952, reflect the generally favorable financial position of companies engaged in aeronautics.

The Finance Committee has held four meetings during the year and was available to the Council at all times for advice and consultation. It has maintained constant check on all investments under its jurisdiction. The recommendations made by the Committee have been consistently on the conservative side with a view toward conservation of principal by the purchase of highest quality securities rather than investment in more speculative types that might yield higher income rates. The I.A.S. Portfolio now shows current market value of approximately $36,000 over book value and yields an average return of about $3^1/_2$ per cent annually.

The total of unrestricted assets increased from $494,000 to $826,000 by the addition of the proceeds from the sale of the Guggenheim property of $332,000. Initially, Daniel and Florence Guggenheim Park at Sands Point, which had been given to the Institute by Mrs. Florence Guggenheim in 1942, was carried on the books at $1.00. In October, 1951, the property was sold to the United States of America and the proceeds invested.

The day-to-day operations proceeded in a normal fashion during the past year. Periodic reports were presented to your Council and Executive Committee for study and discussion. The auditors—Harris, Kerr, Forster & Company, Certified Public Accountants—have stated in their letter of transmittal that all transactions were in accordance with the purposes for which intended, that by test verification all receipts were properly recorded, and that the report fairly presents the result of operations for the fiscal year ended September 30, 1952.

Contingency reserves have been set up out of current operating surplus for the Employees' Retirement Fund, Furniture and Equipment, and Building Repairs. In planning for the next scheduled International Aeronautical Conference, a fund has been accumulated to offset some of the extraordinary costs that will be incurred.

The JOURNAL, REVIEW, and CATALOG all showed an excess of income over expenses. Although our JOURNAL publishing costs increased, several hundred additional subscriptions were accepted which increased income considerably.

The AERONAUTICAL ENGINEERING REVIEW's growth in revenue and nonrevenue pages during the past year has been self-evident. The expectations are that the current year's operations will continue at about the same level.

The West Coast Office continued operating on the same basis as in prior years, with an income of $19,155 and expenses of $21,486. Through the continued effort of the local officers and committees, it is expected that costs may soon be reduced and income increased so as to operate on a break-even basis. C.V.A.C. is still occupying the San Diego Building. We have been notified, however, that the lease will be terminated on February 10, 1953.

No significant changes are reported in the Pacific Aeronautical Library operations. Its Balance Sheet now shows assets of $11,348.

The Executive Committee has reviewed the 1952–1953 budget. This, as with previous budgets, has been prepared on a conservative basis and indicates a probable net unexpended income of about the same order as this year.

A digest of the Institute's fiscal report is published on page 19.

Any additional details are available to members at the national office.

CHARLES H. COLVIN
Treasurer

INSTITUTE OF THE AERONAUTICAL SCIENCES, INC.

Statement for the Fiscal Year October 1, 1951, to September 30, 1952

Consolidated Balance Sheet and Operating Statement

ASSETS

Unrestricted			
General Fund:			
Cash on Deposit		$ 45,314.30	
Accounts Receivable—Net		34,071.52	
Advance on Intrafund Accounts		24,246.36	
Deposits and Prepayments		16,723.44	
Furniture and Fixtures		5,000.00	
Investments		701,438.66	
Books, Prints, Models, Medals, etc.		1.00	
Aeronautical Index		1.00	
Total Unrestricted Assets			$826,796.28
Restricted			
Special:			
The Minta Martin Aeronautical Fund		$591,511.97	
Others:			
The Thurman H. Bane Award Fund	$ 330.81		
The Sherman M. Fairchild Fund	14,612.95		
The Paul Kollsman Fund	69,000.00		
The Vernon Lynch Award Fund	38,314.28		
The Sylvanus Albert Reed Award Fund	13,468.15		
The Lawrence Sperry Award Fund	13,377.00		
San Diego Building Capital Fund	3,525.36		
Los Angeles Building Operating Fund	19,084.73		
Pacific Aeronautical Library Fund	11,348.41		
New York Building Contingency Fund	105,686.16	$288,747.85	
Total Restricted Assets			$880,259.82
Facilities			
Buildings, Land and Equipment:			
New York		$219,254.34	
Los Angeles		398,741.79	
San Diego (land leasehold)		176,706.11	
Total Facilities			$794,702.24

LIABILITIES, RESERVES AND UNEXPENDED INCOME

Unrestricted Funds.		
Accounts Payable and Deposits	$ 54,553.19	
Deferred Credits to Income (Dues and Subscriptions)	86,767.93	
Deferred Income—San Diego Building Rental	16,961.22	
Contingency Reserves	120,573.45	
Surplus:		
Balance September 30, 1952	547,940.49	
Total		$826,796.28
Restricted Funds		$880,259.82
Land, Buildings, and Equipment:		$794,702.24

Statement of Income & Expenses

Income:		
Advertising Revenue	$239,674.25	
Dues and Entrance Fees	194,830.11	
Subscriptions	59,177.32	
Income from Investments	21,241.32	
Miscellaneous	1,474.69	
Total Income		$516,397.69
Expenses:		
Publications	$247,590.91	
Salaries (Administrative, Accounting, and Clerical)	113,268.63	
Contributions to Employees' Retirement Fund and Reserve Toward Future Costs	51,799.54	
Building Maintenance and Reserve for Alterations and Repairs	24,187.28	
Meetings and Travel	20,583.72	
Libraries (excluding P.A.L.)	17,150.67	
West Coast Offices	13,202.34	
Printing, Postage, Telephone, and Telegraph	8,060.90	
Office Supplies and Expenses, Insurance	7,156.16	
Furniture, Fixtures, and Reserve Therefore	4,000.00	
Miscellaneous	2,912.15	
Total Expense		$509,912.30
Net Unexpended Income		$6,485.39

Director's Report—1952

ONCE AGAIN YOUR MANAGEMENT is able to report continuing upward trends in all phases of Institute activity. As has been noted in the Treasurer's Report, we are living well within our income and are able to put a little something aside for the possible "rainy day." The Institute is in stable and healthful financial condition.

General Activities

The Institute now finds itself in an extremely active year in all areas of its many fields of interest and in all parts of the country—in fact, in many parts of the world. The current program at the national level includes such events as:

October 31, 1952: Presentation of the Musick Memorial Trophy on behalf of the Royal New Zealand Aero Club. The Institute and The Royal Aeronautical Society are joint sponsors. Wings Club, New York.

November 13–14, 1952: Inspection Tour, Naval Air Material Center, Philadelphia, and Naval Air Development Center, Johnsville, Pa., by Institute group.

December 1, 1952: Air Cargo Day, Joint Participation with National Security Industrial Association, Society of Automotive Engineers, and The American Society of Mechanical Engineers. Hotel Statler, New York.

December 2, 1952: Heavy Press Program in collaboration with The American Society of Mechanical Engineers, Society of Automotive Engineers, American Institute of Mining & Metallurgical Engineers. Hotel Statler, New York.

December 3, 1952: Presentation of the Daniel Guggenheim Medal at The American Society of Mechanical Engineers Dinnner. (This is a joint activity with The American Society of Mechanical Engineers and the Society of Automotive Engineers.)

December 12, 1952: Second Convertible Aircraft Congress sponsored by The Franklin Institute and assisted by the Philadelphia Section of the Institute and the American Helicopter Society.

December 17, 1952: The Sixteenth Wright Brothers Lecture, Washington, D.C., Chamber of Commerce Auditorium. The Wright Brothers Memorial Trophy and Collier Trophy for 1952 presented at the Aero Club of Washington Dinner. (The Institute is represented on selection boards for both these Trophies.)

January 26–29, 1953: Twenty-First Annual Meeting, Hotel Astor, New York. Joint Sessions were included with American Helicopter Society, Institute of Navigation, American Meteorological Society, Institute of Radio Engineers, Radio Technical Commission for Aeronautics, the Soaring Society of America, and The Daniel and Florence Guggenheim Aviation Safety Center at Cornell University.

March 13, 1953: Eighth Annual Flight Propulsion Meeting, Cleveland. Supported by the Institute's Cleveland Section and in collaboration with the Lewis Flight Propulsion Laboratory of the National Advisory Committee for Aeronautics.

May 20–22, 1953: International Telemetering Conference, Chicago. Held jointly by the Institute of the Aeronautical Sciences, American Institute of Electrical Engineers, Institute of Radio Engineers, and Instrument Society of America.

July 15–16, 1953: Annual Summer Meeting. Los Angeles.

September 7–17, 1953: Fourth International Aeronautical Conference, The Royal Aeronautical Society and Institute of the Aeronautical Sciences, London, England.

It will be noted that many of these events are held in collaboration with other technical societies. It is our policy to foster such collaboration at all levels, national and local. We plan to fit our own programs into all joint efforts to further the common cause.

One measure of I.A.S. progress is in the rising tide of Section and Branch activity throughout America and Canada. From the standpoints of both quality and quantity, our regional and our scholastic meetings have never been better. Our Membership Department has come up with a few statistics that show that our 25 Sections will hold over 175 technical sessions this year and that our 70 Student Branches will conduct over 350 meetings. Added together, this comes to almost two I.A.S. sessions of some kind or another per working day the year around.

I.A.S. Section activities are being promoted through increased staff visitations. Within the past months, staff members have visited Section activities in Pittsburgh, Cleveland, Buffalo, Toronto, Montreal, Ottawa, St. Louis, Wichita, Fort Worth, San Diego, Los Angeles, San Francisco, Seattle, Chicago, and Detroit. Plans are now being made to cover Sections in eastern and central parts of the country on the same basis.

A Chairman's Circular News Letter has been inaugurated. This report is circulated every month on a restricted basis to Section Chairman and Secretaries and is intended to be a "hair-down" discussion of Section problems for the information of all hands. A number of good ideas have been tried in some parts of the country which can well be applied elsewhere.

A companion piece is a periodic news letter to Chairmen of the Student Branches for the same purpose. All Sections are urged to participate in Student Branch activities, to organize regional student meetings, and to set up student competition papers, etc.

A circulating film library has been set up on the East Coast and on the West Coast to make available to Section and Student Branches worth-while technical films. These films have been secured both from industry and from the Armed Services.

Increased financial support has been budgeted for 1952–1953 to take care of these activities.

Membership

I.A.S. membership continues to increase at a normal and satisfactory rate. This year, for the first time, graded membership exceeds the 9,000 mark. Net increase in membership for the year totals 511. Of primary interest is the fact that 80 per cent of our members are enrolled in our 25 Sections.

The comparative statistics on membership over the past 3 years are as follows:

	12/50	12/51	12/52
Temporary Honorary Members	18	14	18
Honorary Fellows	22	24	26
Fellows	184	183	191
Associate Fellows	635	665	699
MEMBERS	3,114	3,218	3,511
Associate Members	367	368	399
Historical Associate Members	68	67	70
Technical Members	3,899	4,102	4,238
Total Graded	8,307	8,641	9,152
Student Members	3,395	3,006	2,796
Total	11,702	11,647	11,948

Library

About a year ago, a major review of Library programs and procedures appeared to be necessary. John Glennon, then Acting Librarian, made a detailed study and an excellent report, supplemented by an outside Librarian Advisory Agency. This has resulted in a complete physical rearrangement of our Library, including the installation of new steel shelving in the basement, redisposition of old bookcases to the second and sixth floors, and a complete rearrangement of both the Kollsman and Burden libraries to segregate the little-used material from the active. One of the greatest needs has been for a Cataloger for our book collection. A

cataloger and a typist have been retained to work under Mr. Glennon's direction, and it is anticipated that this job can be finished within the next 12 months.

Use of the Library by I.A.S. members and the public continued to increase during 1952. A total of 4,847 volumes was loaned through the Paul Kollsman Lending Library, a gain of 15 per cent over 1951. Seventy per cent of these loans were made to I.A.S. members. Six hundred and eighty persons visited the Reading Room and used 1,064 volumes from the basement stacks. These visitors also made frequent use of the reference works, historical books, bibliographies, indexes, and periodicals (approximately 300) kept on open shelves. The photograph and clipping collections were in constant demand. One hundred and sixty-three orders for photostatic and microfilm copies were filled. The Library also gave assistance to other I.A.S. departments in answering reference and information requests.

Approximately 600 items were added to the book collection, and 2,400 items to the report collection. At the end of the year, approximately 375 periodical titles were being received. Many of these publications were presented to the Library by various individuals, companies, research organizations, and Governmental agencies. New Library membership totaled 106, of which 23 were for representatives of I.A.S. Corporate Members.

Late in the year, 500 copies of "Books on Selected Technical Subjects in the I.A.S. Library (up to 1950)" were printed. Distribution of copies was made through the I.A.S. Corporate Members, and the balance of the stock was placed on sale through the I.A.S. publications department. Publication of the fifth annual volume of the AERONAUTICAL ENGINEERING INDEX, for 1951, was completed in October.

Our objectives in the Library program have been:

(1) To provide the kind of Library services that are needed by our type of membership in this area.
(2) To operate the Library efficiently at our scale at a minimum cost.
(3) To know what we have in the way of books and to be able to find them and to replace them with a minimum of effort.

This is a long-term job, but it is now well under way and the expectation is that by mid-1953 we will have the Library reorganized as we feel it should be. The costs of this operation have been included in our present budget.

Publications

All I.A.S. publications are enjoying a period of relative prosperity, as indicated by the Treasurer's Report. The REVIEW is recognized as the leading engineering publication in its field, both by its readers and its advertisers. The CATALOG has a considerable earning potential. The JOURNAL continues to provide our membership with essential scientific information on a practically break-even basis. Thanks to special advertising support, the ROSTER is also on a break-even basis.

During the course of the past year the editorial content of the JOURNAL has been averaging 72 pages per issue. The REVIEW averages about 136 pages per issue, of which approximately 55 per cent are editorial matter and 45 per cent advertising. The CATALOG has increased in total volume by approximately 20 per cent. The Directory Sections have been rearranged and expanded to increase greatly its utility.

Preprints, reprints, and special reports published under The Sherman M. Fairchild Fund totaled 39 during 1952. Approximately 7,500 copies of various titles were distributed during the year.

Los Angeles Operations

The Los Angeles Building ended its fiscal year with a slight deficit, which was picked up from our general funds as indicated in the Treasurer's Report. All reports indicate that the Building and the Section activities on the West Coast are being efficiently handled by our Western Manager, E. W. Robischon. Detailed reports on all Western Region activities have been presented to the Council of frequent intervals.

San Diego Building

The San Diego Building, which has been leased to Convair for the past $2^1/_2$ years, was returned to the I.A.S. in mid-February, 1953. As was anticipated, it was returned to us in fully renovated condition in accordance with the terms of our agreement with Convair. Meanwhile, a fund of approximately $20,000 has been accumulated for the future support of the building.

Affiliate Program

The increased support for the American Helicopter Society, made possible by the use of the Guggenheim Fund, went into effect September 1, 1952. Harry Lounsbury has been retained as Executive Secretary of the Society and has been taking hold of its activities satisfactorily. He is assisted on a part-time basis by Miss Catherine Schneider, who has been retained as Custodian of the Museum.

Museum

We were fortunate in securing Miss Catherine Schneider from the display division of the Museum of Natural History. Miss Schneider has had 5 years' experience in the Museum of Natural History and has a working knowledge of display and general Museum techniques. She came to us on October 15 and has started on a program of completing the Cataloging and special exhibits from time to time. The editorial direction of AERONAUTICA has been transferred to E. W. Robischon in Los Angeles.

General

During the Spring of 1952, with the approval of the Council, your Director served as Executive Director of the President's Airport Commission under the Chairmanship of Gen. James H. Doolittle. During the entire year your Director also served as a Member of the Aeronautics Committee on the Research and Development Board. He is presently Chairman of the Aeronautical Engineering Advisory Council of Princeton University.

As directed by the Council, the I.A.S. staff was polled as to its desire to participate in Social Security Program. The preponderance was favorable and the I.A.S., as of October 1, 1952, is now on a Social Security basis.

Because of the increasing scope and tempo of all I.A.S. activities, some rearrangement and augmentation of the Staff has been necessary. All bases are now satisfactorily covered, and an obvious spirit of "team" operation prevails throughout our working group. I should like to take this opportunity to express my thanks to all members of the staff for the excellent jobs they are all doing to further the objectives of the Institute. Our thanks also to the Officers and Council for their continuous (and highly necessary) support. We are particularly grateful to all the officers and committees of our Sections and Branches for the fine work that is being done to promote I.A.S. activities in all parts of the country.

S. PAUL JOHNSTON
Director

(*I.A.S. News continued on page 62*)

INSTITUTE OF THE AERONAUTICAL SCIENCES

Flight Safety Foundation Award

for Distinguished Service in Achieving Safer Utilization of Aircraft

Editorial

One One-Hundredth of One Per Cent

This issue of the REVIEW has been dedicated to the subject of "safety" for several reasons. First, because it comes on the heels of Flight Safety Foundation's Annual Air Safety Seminar recently held in Bermuda. More importantly, because the factors bearing on this subject have increased in scope almost in proportion to the speed, size, and number of today's airplanes. More and more, air safety has become the responsibility of *all* who are interested in aviation.

That this responsibility has been taken seriously is proved by the operating records of the past 5 years. During this period, the scheduled air lines of the United States have flown 99.99 per cent of their passengers without accident. (A pilot flying one of these air liners 1,000 hours per year would have a life expectancy of 400 years.)

But that one one-hundredth of one per cent is the fraction that makes newspaper headlines. Measured in terms of human lives, financial loss, and public confidence, it is a figure that demands constant vigilance and continuing research.

Most aviation accidents in this day and age are the result of seemingly far-fetched incidents or chains of events. For example, a pilot places his cup of coffee on an instrument housing, the floor, or other convenient flat spot while he attends to some necessary cockpit procedure; turbulence sloshes some of the liquid; it seeps down into vital wiring or an electrical component ... things begin to happen!

Or, take some of the cases where metal objects, brought into the cockpit or loaded into forward baggage compartments, have had a magnetic effect on compasses and other sensitive instruments. The several degrees error caused in heading may mean the difference between missing and hitting a mountain peak or other object in instrument weather.—Ice forms on the wash basin drains; big chunks loosen and fall as the aircraft descends...some person may be struck, or his housetop is perforated.—A cigarette lighter drops from a shirt pocket as someone stoops over; it lands on its trigger; gas fumes are present...a hazard is created.—A pilot lines up his approach glide on lights or a line on the horizon in the early morning mist; atmospheric conditions are just right to create a "sensory illusion"... the airplane makes a perfect landing in the river 500 ft. short of the airport runway.—Smoke or dust sets off an automatic fire extinguisher in a baggage compartment; dangerous fumes, odorless and colorless, seep into the pilot's compartment...perhaps rendering the crew unconscious.

Far-fetched? Yes—but these, and other incidents as seemingly unlikely, *did* happen. No manufacturer, operator, or pilot is to blame. Yet they, and the entire aviation industry suffer as a result. The passengers and crews in some of these cases are now a part of a vital statistic...one one-hundredth of one per cent.

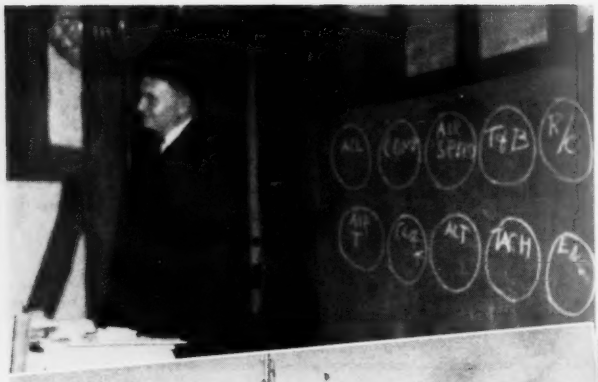
A repetition of such accidents and the occurrence of equally futile ones in the future can be avoided by the free (but confidential) interexchange of information, experiences, and ideas. Most manufacturers and operators of airplanes employ safety engineers and experts in their own organizations. But they also recognize the need for an independent "policing" body whose sole mission in life is "safety" in the common interest of all. It is this need that led to the establishment of Flight Safety Foundation, Inc., and resulted in the valuable services that body is giving the industry today.

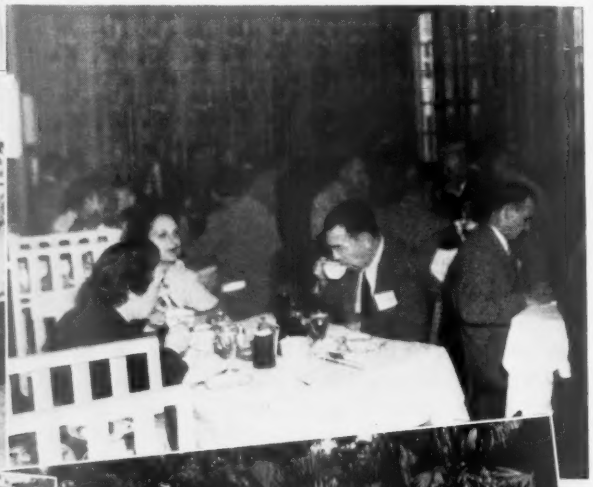
The Annual Seminar, which provides a confidential platform where anybody (except reporters) may participate and let their hair down, is but one of these important services. Here, airplane designers, doctors, air-line executives, manufacturers, pilots, and civil and military Government personnel can (and do!) discuss everything from safety torque wrenches to a pilot's basic metabolism.

The articles published in this issue are but a sample of the papers presented at the latest Air Safety Seminar. They have been selected primarily to indicate the growing breadth of the fields affecting air safety and to create an awareness of the work being carried on.

The Institute and many of its individual members have a direct interest in the Flight Safety Foundation. *Everybody* has a stake in its mission...to reduce to the vanishing point that fraction—one one-hundredth of one per cent.

W. A. S.





As these candid shots might indicate, wives of the delegates to the Air Safety Seminar were the only ones who saw much of Bermuda's sunshine. Hard-driving taskmaster Jerry Lederer *(left)* kept interesting sessions rolling from early morning until late at night—and right through mealtimes. This probably explains the "sun-squints" of Colonel Ellis *(bottom left)* and the obvious happiness of the Bill Littlewoods *(bottom right)* at seeing each other again when the Seminar was concluded on Saturday. Appropriately enough, this day found "Jerry" enjoying the support of two posts on a Bermuda street corner *(bottom center)*, while the "Mrs" completed her shopping. (EDITOR)

The Bermuda Air Safety Seminar of 1952

JEROME LEDERER*
Flight Safety Foundation, Inc.

Technical Session in progress from early morning until late at night at the Bermudiana.

THE PURPOSE OF THE Air Safety Seminars is to provide specialists in flight safety an informal opportunity to air their opinions on numerous safety problems and to offer for criticism the results of their safety studies. No official minutes are made, and much of the material is off-the-record. There are no widespread announcements of the Seminar, and there is no desire to attract a large attendance. The participants work very hard from 9 a.m. to midnight for 3 days. About one-third of the agenda is devoted to demonstrations of new safety devices or techniques.

The participants leave these Seminars with a broader outlook on air safety problems, with a better understanding of the other fellow's point of view on controversial safety problems (such as aft facing seats or flight recorders) and with considerable good-natured resentment toward the Director of the Flight Safety Foundation for driving them so hard.

These Seminars have been held at Sands Point, Denver, and Bermuda. The reason for Bermuda is to prove easier accessibility for European participants (currency restriction) and the joint cooperation from M.A.T.S. and the Coast Guard which is available there. The military services of the United States and Canada have cooperated wholeheartedly in these seminars. The list of participants in the Fourth Seminar (page 29) will show how many other organizations cooperate and is an indication of the aviation industry's overriding interest in air safety.

AWARDS FOR SAFETY

These Seminars also furnish the opportunity to recognize significant contributions to the safer utilization of aircraft by the awarding of special plaques to selected individuals or organizations. This year they were awarded to:

The Republic Aviation Corporation
"for early perceiving and establishing the importance of a department specializing in Design Safety"

Captain P. P. Cocquyt, Chief Pilot, Sabena Air Lines
"for developing a theory of sensory illusions which explains several mysterious accidents of the past and which should be helpful in avoiding accidents in the future"

John Lindberg, Sperry Gyroscope Company, and Pan American World Airways
"for developing the electronic Engine Analyzer which enables the crew to isolate power plant malfunctioning in flight"

The Directorate of Flight Safety Research, U.S.A.F.
"for establishing the significance of safety as an integral part of operating efficiency"

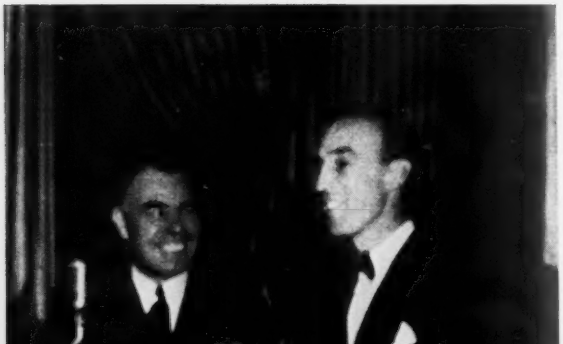
The awards are in the form of a symbolic plaque shaped in the triangular form of modern aircraft wings. The words "Flight Safety Foundation" bound the triangle. The center of the triangle is occupied by a profile of the Globe, with the 24 hours of the clock shown on the periphery to denote that distance is now subordinate to time.

The vertical legs of the "M's" are shaped in the form of screw jacks pressing against the Globe, the whole representing the idea that the airplane is squeezing the world into smaller space through intelligent use of man, machine, medium—but with safety. In each corner of the triangle is an "eye" to denote that aviation requires constant vigilance if it is to reach the objective of becoming the safest form of transportation. (See page 22.)

Fire Foam on Runway Saves Airplanes

The plaques, donated by *Aviation Week*, were presented at an "award" dinner. The occasion was fortunate in having General O'Keefe, of the Directorate of Flight Safety Research, U.S.A.F., present to show how a small item in the Directorate magazine *Flight Safety* had saved at least three fighter airplanes from destruction saving the taxpayer almost $1,000,000. His motion picture showed a fighter that had been destroyed because it landed with its nose wheel cocked

* Director.



Captain P. P. Cocquyt receiving the Flight Safety Award from the hands of Wing Comdr. E. M. Ware, Director, Bermuda Board of Civil Aviation.

over to one side. This was followed by motion pictures showing how this type of accident can be avoided very simply by spraying the runway with fire extinguishing foam in accordance with a suggestion in *Flight Safety*. The guests were then held spellbound by a tape recording of a jet pilot describing the serious troubles that befell him on a ferry flight because of minor departures from good practice, such as leaving his flashlight behind.

The Discussions

Eight of the 45 discussions of this Seminar are reproduced in this issue of the Aeronautical Engineering Review. This does not mean that others are of less importance. Some were of an organizational nature rather than technical. Typical of these non-technical but important talks was the discussion on crew discipline entitled "Crime and Punishment" by Dr. Kenneth Andrews, of Harvard, and "ALPA Organization for Safety" by Clarence Sayen, President of the Air Line Pilots Association. They will be published by the Flight Safety Foundation, along with other discussions, unless they were off-the-record. There is a special demand for one paper in particular, "Sensory Illusions of Pilots" by P. P. Cocquyt. His theories have already been used officially by the C.A.B. to help explain air transport accidents. This will be available from the Flight Safety Foundation.

Medical

The talk on Heart Troubles by Dr. J. E. Smith will be published in the *American Heart Journal*. He said that the crux of life is ability of the heart to accelerate blood. The pattern of this acceleration denotes either trouble or normality." The Bureau of Standards is developing an instrument to predict heart trouble with this as the key.

Captain Peterson's paper on "Ventilation" questioned the amount of permissible exposure to carbon monoxide and pleaded for the discontinuance of recirculated air in the pilot compartment. This was supplemented by Captain Buck's discussion of crew efficiency as affected by passing through several time zones. These will be available from Flight Safety Foundation.

Dr. Ludwig Lederer on "Pilot Aging" declared that heart disease and cancer were probably the only serious threats to a pilot's existence and that chronological age is not a true criteria for measuring pilot competency. The point at issue is: "When are physiological and psychological changes due to aging no longer compensated by judgment, skill, and experience."

The discussion on "The Economic Justification of Flight Recorders" is awaiting a detailed supplement. Automatic records can ease the burden of maintaining logs; they also may improve crew efficiency, anticipate an accident, and provide valid testimony after an accident.

Dr. Kidera showed the advances being made to maintain flight crews in an "airworthy" condition by anticipating and preparing for organic troubles. His paper on "Predictive Diagnosis" will be found on page 31.

Approach and Landing: The Aerial Ballet

About 20 per cent of serious accidents occur on approach and landing. Captain Jenks' talk on this subject is not reproduced here because he presented a more elaborate paper on this subject at the 1953 Annual Meeting of the I.A.S. But his opening remarks are of interest:

"The safe termination of any flight is the payoff of any type of aerial transit, whether it is commercial or pleasure and it also applies to a high percentage of military operations. The ordinary aspects of landing an aircraft involve such things as pavement, speed, weight, control, reasonably clear approaches, and many other things. All of these make interesting topics, but I believe the subject of prime importance is the approach and landing of aircraft *in weather*.

"In a brief way, this will be a description of the aerial ballet that takes place in the clouds adjacent to every major air terminal during weather. The show is an all-star cast and the spotlight is on the star of the moment—the aircraft on final. Let anyone of the supporting cast miss a cue or muff a line and the whole show is fouled up."

Brantley, of Cornell, brought the group up to date on Doppler Radar and continuous-wave radar techniques for collision prevention. His talk is available from Flight Safety Foundation. It was supplemented by a motion picture of a surveillance radar scope in the New York area, which showed the immense amount of traffic that has to be handled and confirmed the aerial ballet concept of Jenks. Sam Saint discussed "Airborne Radar" and related problems. Christenson, of

United, showed the latest in anticollision lights. Mel Gough discussed some of the reasons why it takes time for an airplane to change its attitude and how this can be dangerously critical on an approach.

Haynes' report on "Final Approach Visibility Studies" is on page 44.

Karl Fairbanks showed how approach, landing, and take-off can be scientifically evaluated by a new photographic method. This paper is available from Flight Safety Foundation.

Safety Concepts

The talk by McInnis on "Internal Communications in the Safety Program" highlighted the oft-neglected point "There is One Thing Certain—The Safety Program Will Not Be Fully Effective Until the Employee *Accepts The Ideas As His Own.*" Flight Safety Foundation will publish this paper.

Mr. Hayhurst (British Ministry of Supply) created considerable controversy in his talk on "Training of Designers on Safety Problems" by questioning the advisability of safety organizations as such. He said that cooperation between government authorities and the (British) industry is such as to make designers continually alert to questions of safety; a contributory factor is the compactness of the British industry. Hence, design safety organizations such as used by several American manufacturers are not necessary. This paper will be published later.

Compulsory Safety Codes

Muench's paper on "ICAO's Concept of Airworthiness Requirements" brought out an interesting regulatory problem:

"The status of the international airworthiness code is at present a somewhat peculiar one. Contracting States are not at present under any obligation to issue certificates of airworthiness classifying airplanes in an ICAO Transport Category. Any State may, however, do so if it so desires, provided that the airplane so certificated meets the specifications established in the code for the category concerned. So far little use has been made of this provision and existing Certificates of Airworthiness still classify airplanes in national categories of airworthiness. Nevertheless, since existing national codes in general include the material specified in the international code, most of the transport airplanes built at present would be eligible for certification in an ICAO category.

"This concept of an International Airworthiness Code was not originally envisaged. The international code has been prepared on the assumption that it would form the basis for the issue of certificates that would be recognized internationally for the purpose of flight over the territories of Contracting States and it could be applied without much elaboration on a national basis. At first sight, it appeared that a single airworthiness category could include all airplanes intended for the public transport of passengers, cargo, or mail in international air services. The idea of having a single category of transport airplane, however, had to be dropped as it was realized that one category could not, in detail, cover certain airplane types that have shown in the past a high level of safety when used under appropriate operating conditions. Thus Contracting States were faced with the problem of establishing a suitable system of various transport categories. This problem as was mentioned before is at present not completely solved. The ICAO Council took subsequently the view that compulsory application of the international code could not be required until at least such time when the code would define a complete set of airworthiness categories.

"The degree of completeness as well as the amount of detail into which ICAO airworthiness standards should go is unfortunately a somewhat contentious matter, and various ICAO bodies are at present studying a policy that might be accepted universally in this respect. The broad question is can an airplane embodying a feature for which there are no applicable ICAO standards be certificated in an ICAO category?"

Flight Safety Foundation will publish this paper.

Clarence Sayen, President, Air Line Pilots Association.

Accident Survival and Evacuation

Dr. King's paper on "Time Losses In Emergency Evacuation" is appropos of the current interest in high-density aircraft. The public does not think in terms of statistics but in terms of disagreeable consequences. Dr. King shows how some of the consequences may be made more acceptable by proper training and facilities. Avelar described his development of a self-contained emergency evacuation slide. See page 37.

Noise

Noise is probably the most important problem facing the air transport industry. Noise may require a pilot to follow unusual maneuvers to avoid disturbing our "good neighbors" below. Swartzel's paper on noise is an excellent summary of the situation. His outlook for a solution seems pessimistic, but perhaps the very importance and difficulty of the challenge will produce the answers. See page 49. John Groves, of the A.T.A. had everybody weeping when he described the problems that noise creates for the air lines!

Incident Reporting

It is significant that the Strategic Air Command was recently awarded the Daedalian Trophy for its outstanding success in lowering its accident record. The reporting of "incidents" that are not yet "accidents" contributed importantly to this success. It is extremely difficult to persuade pilots to report near misses and other incidents. On page 32 Col. Ellis tells how S.A.C. went about it.

Human Engineering

Norris, of Boeing, described a new system for passing safety information (design type) on to large design staffs. Dr. Seitz introduced a new symbol into engineering design. The "H" factor. It represents the knowledge accumulated by psychologists, physiologists, and physicians which may be applied by the engineer to adapt this design more efficiently to the user. This fascinating study of designing the machine to fit the man is assuming prominent importance in aviation. Its importance to accident prevention is obvious whenever a crash is ascribed to "Pilot Error." This paper is reproduced on page 42.

The excellent record of M.A.T.S., in view of its worldwide obligations, is due in large part to its Pilot Standardization Program; a system for training and providing for periodic technical exercises which promotes uniform procedures so that crew members become coordinated teams. This paper will be available from Flight Safety Foundation.

The Angle of Attack Indicator, courtesy of Steve McClellan, The Land Air Engine Analyzer, the Crash Fire Rescue Operations at Kindley Air Force Base, the air-sea rescue demonstrations with the cooperation of M.A.T.S., and the U.S. Coast Guard furnished all the participants with useful information and unforgettable experiences.

Survival

The problems of crash survival face the designer when preventive measures fail and accidents occur. Dr. King's discussion on emergency evacuation has already been mentioned. His motion pictures on ditching problems showed that there is much room for improvement. What about ability to use the emergency exits? How can passengers be given more assurance of surviving a crash with little or no injury? After they get out of the airplane how will they survive life on a raft or in the tropics? An interesting film by Beech showed the benefits of shoulder harness. For clues on other problems read De Haven's remarks on "Rearward- and Forward-Facing Seats," page 40, and Nesbit on "Survival Worldwide" on page 55.

Now you see why we worked from 9 a.m. to midnight!

Sessions — Air Safety Seminar

Tuesday, November 18

Evening—Announcements and Registration

Wednesday, November 19

Morning

Flight Recorders

Film of an Actual Crash, Jerome Lederer.
Economic Justification of Flight Recorders, Ira Thatcher.
Message Repeater, Mohawk Business Machines, 47 West St., New York.
Description of Recording Instruments—Peravia (Swiss), SFIM (French), NADAR (North American), Tape; Ruland M. Woodham.
C.A.A./C.A.B. Recorder Program, John Easton and John Chamberlain.

Medical—Chairman, Dr. Ludwig Lederer

Irregularity of Pilot Living on Efficiency, Robert Buck.
Cockpit Ventilation, Capt. Vernon Peterson.
Predictive Diagnosis, Dr. G. J. Kidera.
Pilot Aging, Dr. J. E. Smith and Dr. Ludwig Lederer.

Luncheon

"Crime and Punishment," Prof. Kenneth Andrews.

Afternoon

Accident Survival—Chairman, Capt. R. L. Burke.

Rearward- vs. Forward-Facing Seats, Hugh De Haven.
Elimination of Some Time Losses in the Emergency Evacuation of Passengers from Airplanes, Dr. Barry King.
A Program for Study of Passenger Escape and Survival Following Ditching, Dr. Barry King.
Shoulder Harness Film, Beech Aircraft Corporation.
New Developments in the Evacuation Chute, John Avelar.
Angle of Attack Indicator, Stephen McClellan.

Evening

ALPA Organization for Safety, Clarence Sayen.
Anti-Skid Tire, Edward Dye.
Sensory Illusions, Capt. P. P. Cocquyt.
Land-Air Engine Analyzer, Robert Cain.

Thursday, November 20

Morning

Human Problems

Realism in Crew Training, Robert Buck.
Survival Worldwide, Paul H. Nesbitt.

Performance

The Approach and Landing Problem, Arthur Jenks.
Mushing, Melvin Gough.
Final Approach Visibility Studies at Airports in the United States, B. C. Haynes.
A New Instrument for Accurate Determination of Landing, Approach, and Take-off Technique and Checking Instrumentation, Karl Fairbanks.

Afternoon

Chairman, William Littlewood

Noise, John Groves.
A Review of the Problem of Noise from Aircraft, Karl Swartzel.

Human Problems

Incident Reporting, Col. Frank Ellis.
Pilot Standardization Program, Col. Raymond L. Curtice.
The "H" Factor, Clifford Seitz.

Evening

AWARD DINNER—"Recording of an Incident," Brig Gen. Richard J. O'Keefe

Friday, November 21

Morning

Human Problems

Internal Communications, Eugene Norris, Capt. Frank Crismon, and I. C. McInnis.

Communications and Lighting

Latest Developments on Safety Aspects of Airborne Radar, Dr. James Brantley, Jr.
Radar Film, Airborne Instruments Laboratory.
Terminal Area Radar Traffic Control, S. P. Saint.
Anti-Collision Lights, Capt. Carl Christenson.

Fire

Current Status, A. H. Hobelmann.
Detection, G. J. Bindewald.

Afternoon

Demonstrations at Kindley Air Force Base and U. S. Coast Guard Ocean Station Vessel McCulloch

Static Display—Rescue, Land and Sea, Kindley Air Force Base, Capt. Anthony Ruby.
Crash Fire Rescue Demonstration.
Life Boat Drop.

Evening

Ocean Station Vessel McCulloch—Night Rescue Demonstration

ICAO Concepts, Albert Muench.
The Training of Designers on Safety Problems, J. D. Hayhurst.

List of Participants in the Air Safety Seminar

Professor Kenneth Andrews, Associate Professor of Business Administration, Harvard Graduate School, Soldiers Field, Boston 63.

John F. Avelar, Field Engineer, Air Cruisers Company, 32 Wellington Ave., Clifton, N.J.

R. L. Barner, Aviation Safety, C.A.A., Idlewild Airport, Jamaica, N.Y.

G. J. Bindewald, Aeronautical Sales and Service Manager, Thomas A. Edison Company, Inc., 51 Lakeside Ave., West Orange, N. J.

James Brantley, Jr., Physics Department, Cornell Aeronautical Laboratory, Inc., P.O. Box 235, Buffalo 21.

Frank A. Breen, Aeronautical Sales Engineer, Sperry Gyroscope Company, Great Neck, L.I., N.Y.

W. K. Brett, Shell Oil Company of Bermuda.

Captain Gerard T. Bruens, Deputy Head of Flight Operations, KLM Royal Dutch Airlines, Schiphol Airport, Amsterdam, Holland.

Robert Buck, 157 Brightwood Ave., Westfield, N.J.

Captain R. L. Burke, Operations Officer, Search and Rescue Division, Eastern Area, U.S. Coast Guard, 80 Lafayette St., New York.

Robert Cain, Assistant Chief Engineer, Land Air, Inc., 440 West Superior St., Chicago 10.

John M. Chamberlain, Director, Bureau of Safety Regulation, Civil Aeronautics Board, Washington, D.C.

Carl Christenson, Director of Safety, United Air Lines, Inc., Stapleton Airfield, Denver.

Captain P. P. Cocquyt, Chief Pilot, Sabena Airlines, 261 Avenue Paul Deschanel, Schaerbeek, Belgium.

Richard T. Crane, Coonamessett Ranch Company, Hatchville, Mass.

Frank Crismon, Manager of Flight Operations, United Air Lines, Inc., Denver.

Colonel Raymond L. Curtice, Chief, Chief Pilot Division, Hq. M.A.T.S., Andrews Air Force Base, Washington 25, D.C.

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Predictive Diagnosis*

G. J. KIDERA, M.D.†
United Air Lines, Inc.

THE ABILITY TO PREDICT the course and outcome of a medical and surgical condition has always been a challenge to the medical profession. Formerly, a doctor's clinical ability, as far as the patient or family was concerned, was based to a certain extent on his guess as to when the crisis of pneumonia would occur or when an infirmed patient would die or get better. If the early physicians could have evaluated a patient and could have stated that he would be dead in 3 weeks or break out in a rash in 2 days, his stature as a physician would have been elevated. Predictive diagnosis takes on an entirely different aspect in aviation medicine. In a sense, every time a doctor makes a diagnosis he makes a prediction. Once a diagnosis is made, usually the doctor focuses his attention on certain organs or parts of the anatomy because he knows of the likelihood of these parts becoming affected or breaking down. In a broad category, this can be termed predictive alertness. We are aware of the relation of obesity to heart and blood vessel diseases. We do know that certain body types, such as the tall asthenic, tend to develop lesions of the gastrointestinal tract. These correlations and statistics are of profound interest—but only to insurance companies and statisticians. When we deal with a single individual, we must be attuned to all possibilities, and probabilities become only a small factor. When a doctor sees a patient and suspects a certain disease, he cares little that the illness only occurs in 1 per 100,000, since this may be the one in question.

One phase of our job is, of course, to attempt to ascertain that a certain illness or injury is completely cured and that adequate convalescence has been effected prior to returning our flight personnel to active flying duties. Of even greater significance, I believe, is an attempt at a clinical analysis of a pilot in order to make a so-called preclinical diagnosis. (See Fig. 1.) Certain clinical conditions can develop without any warning. These diseases, which have no premonitory signs, defy detection in spite of all of the clinical tests we have at our disposal. I have in mind here, primarily, diseases of the heart and blood vessels. We all have heard of the rare but nevertheless highly publicized instances of individuals who have had a careful physical and laboratory examination and who have been given a clear bill of health, only to collapse within hours of the time that they were pronounced in perfect physical condition by the doctor. Fortunately, these instances are extremely rare. The majority of clinical conditions give us some warning, either by way of symptoms evident to the patient or some test or diagnostic sign elicited by the examining physician. The ideal of Aviation Medicine is that of making a diagnosis preclinically—that is, before the advent of a sign or symptom that makes the patient aware that something is amiss. Somewhere along the scale of normalcy to frank manifest disease, the patient or physician becomes aware of certain abnormalities, and it can be determined that a certain pathologic condition is developing. In our medical departments, we attempt to study the individual minutely in order to detect deviations prior to their reaching sufficient magnitude to be noticed by the patient and by proper corrective measures and treatments reverse the process and return the structure to as close to normal as possible. Here again, we are occasionally faced with an irreversible process, and in spite of all treatment and corrective measures the condtion progresses.

Aviation Medicine today is aimed at determining trends and tendencies toward pathologic states and the institution of adequate treatment in order to reverse a disease process regardless of how slight and apparently insignificant. Certain medical diseases today are known to be due to a deficiency or abnormal internal function. Diabetes is an excellent example of a deficiency of an internal secretion that, when supplied to the patient, can help him to carry on a relatively normal life. And so it is with several other diseases. In certain forms of arthritis, the addition of a hormone can practically restore a crippled patient to normalcy. As research continues, I am certain that many other diseases will be found to be on a deficiency basis, and it may well be that the introduction of some biochemical sub-

(*Concluded on page 48*)

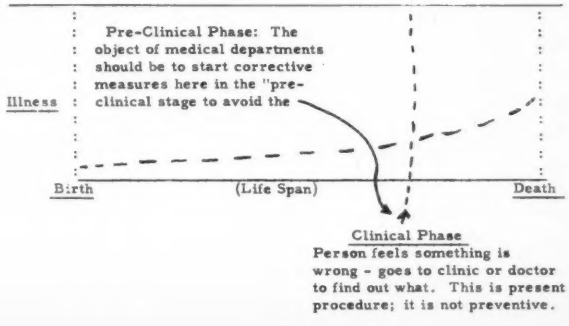
Pre-Clinical Phase: The object of medical departments should be to start corrective measures here in the "pre-clinical stage to avoid the
Illness
Birth
(Life Span)
Death
Clinical Phase
Person feels something is wrong - goes to clinic or doctor to find out what. This is present procedure; it is not preventive.

FIG. 1

Presented at the Air Safety Seminar of the Flight Safety Foundation, Inc., November 19–21, 1952, Bermuda.

* Résumé of Comments.

† Medical Director.

Incident Reporting

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THE HISTORY OF THE INCIDENT REPORT dates back to the first days of aviation when, during hangar flying sessions, pilots exchanged flying experiences regarding their near accidents. Occasionally, these experiences found their way into print, but in most cases they were never recorded. In fact, until just a few years ago, no systematic attempt had been made to explore the source of information afforded by the so-called incident.

It is generally recognized that incidents occur in far greater numbers than accidents and, therefore, can provide a wealth of information if an effective means is devised to ensure a continuous flow of data from this source to those concerned with safety.

Primarily, the foundation of accident prevention measures evolves from experience. From time to time, these measures are supplemented by lessons learned as a result of aircraft accidents. The principal drawbacks in basing new measures solely on accident causes are:

First, a great loss must be sustained before the cause is determined; secondly, in many cases when there are no survivors, the causes are based on assumptions; and, thirdly, many times a series of accidents must occur before the cause is confirmed. Obviously, the unsafe conditions or practices existed before the accidents occurred. Another serious limitation of the prevention program which is principally concerned with accident postmortems is that, in many air operations, accidents are so infrequent that little or no information is available for a continuing emphasis on safety. It has been our experience that, immediately following an accident, the affected organization is definitely safety conscious. This consciousness dwindles away as time erases the memory. While it will always be necessary to exploit every lesson learned from accidents, I believe that eventually we must recognize the limitations of a program of prevention that deals almost entirely with accident studies.

This fact came to be realized in the Strategic Air Command several years after the first great emphasis was placed on accident reduction following World War II. The accident rate throughout the Air Force soared as a result of the rapid demobilization that deprived us of a large percentage of experienced personnel, particularly in the maintenance field. In 1949, when the aircraft accident rate was 54 accidents per 100,000 hours of flying, personnel in flying safety had a wealth of information upon which to formulate preventive measures. These measures were applied and the rate dropped to 41 in 1 year, a reduction of 24 per cent. In 1951, the rate was reduced to 30 accidents per 100,000 hours. It was at this point that further reduction became difficult. We were confident that some progress could be made, but, if the gain was to be appreciable, we would have to look beyond our diminishing accident source. The rate did go down significantly to slightly over 18. We attribute this reduction to an intensive flying safety campaign, plus the institution of incident reporting throughout the command.

Our first experience with incident reporting began in late 1950. At this time, the Eighth Air Force established a requirement for the submission of incident

Presented at the Air Safety Seminar of the Flight Safety Foundation, Inc., November 19–21, 1952, Bermuda.

* Chief, Flying Safety Division.

reports. As a result, some of these reports, which were of command-wide interest, were forwarded to Strategic Air Command headquarters for action. Thus, the value of incident reporting came to be recognized, and the need for a command requirement became obvious. In May, 1951, a S.A.C. Regulation was published. It was almost a duplication of the one used by the Eighth Air Force. The initial response in submitting these reports was not great; however, much useful information began to funnel in. A large percentage emanated from MacDill Air Force Base, where transitional training was being conducted with the B-47, Boeing's six-jet medium bomber. Since the B-47 is a revolutionary type of aircraft, the large number of incidents could be expected. It is significant to note that this was the first time that incident reporting had been used in connection with the operation of a new aircraft. All personnel at MacDill A.F.B. were thoroughly indoctrinated in the preparation and submission of the reports, which were given wide dissemination. After processing a large number of reports, the Flying Safety Officer came to realize that the form being used was not entirely adequate. Many important items were omitted and there was little standardization. He then began to service-test a new form that had been developed by personnel from the American Institute for Research. This form proved to be much more suitable and was adopted command-wide.

I should like to point out that we feel the incident report played an important part in making the B-47 program at MacDill A.F.B. a success, insofar as safe operations were concerned. The number of accidents which occurred was less than had been experienced in similar operations using more conventional aircraft.

Reproduced as Fig. 1 is the incident report form we now use. These forms are placed in all aircraft and in various operations and maintenance offices. A signature is not required, and any other information that might identify the individual may be omitted.

Far more incidents relative to materiel failure are submitted than those that reveal malpractices of crew members or other personnel. During the first year that the incident report requirement was in effect, a total of 490 incidents were reported. Of this number, 83 or 17 per cent were operational in nature—i.e., they dealt with tower operators, GCA personnel, crew members, supervisory personnel, etc. The other 83 per cent included materiel failure, maintenance errors, etc.

It is rather difficult to discuss many incidents in detail, but I do think it would be of interest to at least learn of the action taken as a result of some of them. Only recently, a series of incident reports pointed up the fact that there was a lack of positive coordination among approach control, GCA, and tower operators. This condition was revealed at several of our stations through pilots submitting incident reports. Action is being taken at this time to rectify the situation. Incident reports have also pointed up the fact that GCA personnel do not have access to weather information that is sufficiently current. There is reason to believe that this condition may have been a factor in several accidents occurring during actual GCA runs. Action is being taken now to provide a direct service from the weather office to the GCA facility.

Incidents dealing with materiel failure can be said to be a duplication of a report long required in the Air Force—the Unsatisfactory Report. This report is processed through maintenance channels and ultimately reaches Air Materiel Command. Because the action process on these reports is slow and because they are outside Flying Safety channels, we feel that the incident report fills an important need. I think I can best illustrate this with an example.

About a year ago, three incident reports reached our headquarters relative to anti-icing and deicing deficiencies of C-124 equipment. These reports were so serious that they were brought to the attention of the Commanding General. As a result, he immediately restricted the operation of the aircraft from areas of heavy icing and wrote a personal letter to the director of Flight Safety Research, requesting his assistance in expediting modification of the equipment. The deficiencies of this equipment had been pointed up several times by Unsatisfactory Reports previously filed, but, meanwhile, several accidents were narrowly averted.

The type of incident report that is most difficult to secure is the one that concerns poor technique or judgment by crew members. Most people are reluctant to admit mistakes, particularly if they think they might be used as a basis for disciplinary measures. We are encouraged by the fact that we do receive a few reports of this nature now, and we expect to get many more as our program becomes more firmly established. We received two reports similar in nature which seemed to indicate that the personnel involved were convinced of the importance to safety in revealing the circumstances, even though they reflect carelessness by crew members. On one occasion, a flashlight was laid just back of the engineer's throttles on a C-97. After the pilot had landed the aircraft, he was unable to reverse the propellers. Luckily, no accident ensued. In another case, a can of in-flight rations lodged in the copilot throttle controls when the pilot attempted to reduce power on final approach. These cases could well have gone unreported if the incident report were not functioning.

In some cases, incidents hinge on flying violations. There is a certain area of unsafe flying operation which cannot be adequately covered by regulation. It is as desirable for tower operators to report any unsafe acts they observe as it is for a pilot to report unsatisfactory services from tower personnel. Recently at one of our stations, we received this report from the Base Operations Officer. A C-124 was observed to make a high fast approach, touching down 3,800 ft. down a 5,200-ft. runway. Observers were so certain of an imminent crash that crash crews were alerted and

AIRCRAFT INCIDENT REPORT | REPORTS CONTROL SYMBOL

TO: *(Enter Wing and Station)* Commanding Officer
ATTN: Wing Flying Safety Officer

FROM: Squadron Flying Safety Officer

THRU: *(Enter Squadron and Station)* Commanding Officer

SECTION I - AIRCRAFT INCIDENT *(To be filled in by person reporting incident and submitted to Squadron Flying Safety Officer)*

1. PLACE OF INCIDENT
2. BASE DEPARTED
3. DATE AND Z TIME OF INCIDENT
4. ☐ DAWN ☐ DUSK ☐ DAY ☐ DARK
5. CLEARANCE ☐ VFR ☐ IFR ☐ LOCAL
6. MISSION OR ACTIVITY ENGAGED IN
7. PHASE OF FLIGHT
   a. ☐ TAXIING ☐ TAKE-OFF ☐ CLIMB ☐ LEVEL FLIGHT ☐ DESCENT ☐ APPROACH ☐ LANDING ☐ OTHER *(Specify)*
   b. ALTITUDE *(If applicable)*
8. AIRCRAFT
   a. TYPE
   b. NUMBER
   c. ORGANIZATION AIRCRAFT ASSIGNED TO
9. PERSONNEL *(Completion of this item is not mandatory)*
   a. PERSON AT CONTROLS WHEN INCIDENT OCCURRED
   b. CREWMAN HAVING MOST KNOWLEDGE OF INCIDENT
10. DESCRIPTION OF DAMAGE TO AIRCRAFT *(not sufficient to be classified as an aircraft accident)*[1]
11. NARRATIVE REPORT *(Record in narrative, with all possible detail, everything that is known of the incident. Attach sketches or photographs if available. See Footnote 1.)*
    a. DESCRIBE WHAT LED TO THE INCIDENT[1]
    b. WHAT DID YOU DO?[1]
    c. WHAT WAS THE IMMEDIATE RESULT?[1]
    d. WHAT, IN YOUR OPINION, WAS THE CAUSE OF THE INCIDENT?[1]
    e. WHAT DO YOU RECOMMEND TO PREVENT RECURRENCE?[1]
12. DATE OF REPORT
13. NAME OF PERSON REPORTING INCIDENT *(Print or type)*
14. SIGNATURE *(Optional)*

[1] *If more space is required, use blank sheet of letter-size paper and indicate identification of item, i.e., 11a (cont'd), etc.*

Fig. 1. Sample of Aircraft Incident Report.

they responded. The pilot averted going off the runway by turning onto a run-up area at the end of the runway, leaving a well-defined trail of rubber behind him for some distance. This report was forwarded to the commander concerned, accompanied by a letter from the Commanding General. The pilot's statement that stemmed from the investigation was: "I was giving the copilot practice in landing long." Needless to say, this pilot lost his aircraft commander status.

Sometimes an incident will clarify an accident cause factor. S.A.C. Flying Safety Personnel have an intimate knowledge of all accidents occurring within the command. As they process incident reports, they are able to associate them with any accidents that could have been caused by the circumstances surrounding the incident. About $1^1/_2$ years ago, a B-36 was completely destroyed in an attempted go-around after one prop and a jet pod struck the runway. The accident-investigation board felt that poor aileron control at slow speeds was a cause factor. A few months ago, an incident report was received which reported a malfunction in the aileron-locking system during landing, permitting only partial control. The circumstances were so similar to those of the accident that the accident could have been caused by the malfunction. The system has since been modified.

Occasionally, pilots report as incidents unsafe flying practices that they observe on missions. In one case, a B-36 pilot reported a fighter aircraft making dangerous passes on his aircraft. These attacks were unauthorized and were quickly curtailed by communication with the organization concerned. In this regard, pilots are urged to submit reports of fighter attacks even when scheduled, for we feel that regulations are no guarantee of complete safety in this type of operation. Several serious accidents bear mute testimony to this belief.

Of particular interest at this time are a number of incident reports that may lead to the determination of the causes of several serious accidents.

About a month ago, an F-84 and pilot were lost when the aircraft went into a steep dive out of level flight and crashed without any apparent attempted recovery. The previous day, this pilot had experienced the same difficulty in flight but managed to pull out in time. When he was interviewed, he could not explain what had happened. The Wing Commander was of the opinion, following the accident, that the pilot was suffering from some abnormal mental condition and felt that the cause of the accident would never be determined.

Shortly thereafter, a number of incident reports reltive to malfunction of the elevator trim-tab mechanism were submitted. One reads as follows: "Aircraft was scheduled for high-altitude mission. The pilot found the elevator trim tab out of neutral position during walk around inspection. Upon starting the engine, the pilot neutralized the trim tab and made a normal take-off. He climbed to 42,000 ft. and remained there for 2 hours. Pilot states that he did not use elevator trim from take-off until the point was reached during let-down when he dropped his speed brake. Forward pressure was applied with both hands to counteract the pitch-up tendency of the aircraft. He attempted to roll in nose-down trim with no noticeable effect. The aircraft was landed successfully. A thorough inspection of the elevator trim-tab mechanism revealed no malfunction."

As a result of this and several other similar incidents, an intensive investigation is being conducted in an attempt to determine their causes. The fighter people feel that their solution will have a direct bearing on the accidents that conceivably could have been caused by this difficulty.

On November 7, a B-50 and crew were lost in the United Kingdom when the aircraft was seen to dive into the ground. About 10 min. prior to the crash, communication with the pilot indicated no difficulty. Weather at the time was overcast at 2,700 ft. with tops irregular at 7,000 to 9,000 ft. Severe turbulence had been reported in the area. However, other pilots flying through the same area experienced no difficulty. The investigation, to date, has not revealed a positive cause factor.

An incident report submitted prior to the accident reveals a possible cause factor. In this case, another B-50 was letting down from 6,000 to 2,000 ft. Rate of descent was 500 ft. per min. When an attempt to level off was made, the elevator controls froze in this attitude. By applying extreme force the rate of descent was reduced to about 150 ft. per min. The trim tab was ineffective and appeared to operate more freely than normal. Shortly thereafter, while in a turn, the control column snapped free violently, striking the pilot in the chest. The aircraft was thrown into a nose high attitude of approximately 50° to 60°. Recovery was effected at 140 m.p.h. and a routine landing was made. Investigation revealed no cause. However, based on a previous incident report, the control cables or control surfaces may have been fouled.

It can be assumed that, in the foregoing accidents, malfunction of the control systems was the best possible cause borne out by the incidents. At least this assumption provides a sound basis for further study and corrective action.

These examples will give you a general idea of the information received from our incident reporting program. It is as diversified as it is extensive. One of the prices which must be paid in supporting an incident-reporting program is a large administrative commitment. It is necessary that no attempt be made to have the individuals submitting the report try to discriminate between what is important and what is not important. It is more profitable to discard many irrelevant incidents than to lose one of importance.

In establishing and maintaining an effective incident-reporting system, I feel that the following must be done:

Initially, everyone must be impressed with the importance of an incident. This can best be handled by

an intensive educational campaign and abetted by dissemination of corrective action taken as a result of incidents.

In S.A.C. we have highlighted the importance of the incident by publishing articles on incidents by senior officers and a digest of pertinent incidents each month. Occasionally, incidents are the basis for an article in our Flying Safety publication, *Combat Crew*. Posters highlight their importance also. Down in our operating units, the monthly Flying Safety meetings point up the value of incidents. In this regard, we attempt to develop a critical attitude among flight personnel to be satisfied with nothing but the best.

Secondly, the submission of the report must be as convenient as possible, since it is voluntary. Our forms are readily available and simply designed.

Third, the incident report must not be used as a basis for disciplinary action relative to the individual submitting it, nor should it embarrass him. This can be accomplished by concealing his identity and by positive assurance by authorities that no such action will be taken. Our program includes this stipulation.

Fourth, positive corrective action must be taken and the results of such action made evident to all concerned, particularly those responsible for the initial report submission. We use our incident-report digest, special messages to the field, and dissemination within the organizations to point up the constructive preventive measures that are effected.

Fifth, credit should be given to individuals through whose efforts progress in safety is accomplished. Again, we do this through written publicity, and it is done on a more personal basis in the units.

Sixth, it must be common knowledge that reporting incidents is the privilege of all and is not restricted to flight personnel. This again is a question of adequate publicity. In S.A.C., wings have flying safety officers who are able to follow the various aspects of the problem and to apply emphasis where it is necessary.

Seventh, any incident, no matter how insignificant, must be reported so that qualified personnel can evaluate it. The reason for this has been discussed previously.

Eighth, a system must be set up to record and analyze incidents as thoroughly as accidents. In S.A.C. headquarters, one officer devotes almost full time to this function. The value of such a system increases progressively with the accumulating reports.

These are the basic principles upon which we have founded our program. We feel that we have only begun and that full realization of our goal is far in the future. However, we are greatly encouraged with the progress that has been made thus far.

In closing, I should like to reiterate that we in S.A.C. consider that the incident has a great potential in aircraft accident prevention.

The productive results already obtained justify further efforts, and I feel that the installation of incident reporting by all organizations operating aircraft can, and will, do much to further the cause of air safety.

Attention Members!

All members of the Institute are invited to submit material concerning their activities for publication in the "News of Members" columns of the *Aeronautical Engineering Review*. Responsibility for new developments, awards or honors received, and appointments to new or additional positions are some of the items that your editors believe are of interest to other I.A.S. members. A brief letter or postal card giving exact details will be sufficient. Photographs accompanying news items will be welcomed and will be used where practicable.

Items will be considered on the basis of their timeliness and general interest. Correspondence should be addressed to the News Editor, *Aeronautical Engineering Review*, 2 East 64th Street, New York 21, N.Y.

Elimination of Some Time Losses in Emergency Evacuation of Passengers from Airplanes

BARRY KING*

Research Office of Aviation Safety, C.A.A.

Introduction

Aircraft emergency evacuation is just one phase of passenger survival following accidents. Effective evacuation procedures are meaningful (1) only when the structure and interior design are adequate for prevention of incapacitating crash injury of airmen and passengers under the force-time pattern imposed by the impact; and (2) where means are provided for returning occupants to normal conditions of living when landings are made on the sea or on inhospitable terrain. I will consider only one aspect of crash injury, since this is essential in discussion of passenger escape; I will omit all discussion of survival following escape from the airplane, since this is beyond the scope of this report.

In reporting on the results of studies carried out jointly by members of C.A.A., C.A.B., M.A.T.S., and A.T.A, I will attempt to present the principal findings from evacuation trials on five passenger transport airplanes and from analysis of operational experience. Methods and detailed results are presented in published reports[1–3] or are in the process of publication.[4–8]

The objectives of the study of the emergency evacuation phase of our program are to determine sources of reducible delay and to aid in the identification of effective measures and in comparative evaluation of exits, exit arrangement, and descent devices. The method is based on time-and-motion study of moving-picture records. Passenger age groups are chosen to be characteristic of air passengers. Some of the principal factors influencing the rates of emergency evacuation may be discussed under several headings.

Air Crew

(1) *Survival* of air crew is of paramount importance, since knowledge and effective leadership are perhaps the most significant factors in successful evacuation. The present state of knowledge of crash protection is sufficient to ensure a high probability of survival of one or more cabin attendants.

(2) *Training* can provide an extensive and detailed knowledge of the many factors that may cause delay, appropriate methods of reducing those delays, knowledge of effective measures, and means for applying these measures. Where crews are provided with a considerable fund of knowledge, they can draw upon it, using in various combinations the items appropriate to the situation.

Training should be directed toward appropriate action in unanticipated emergencies—i.e., those in which there is little or no time for preparation prior to impact or landing. The basic plan of action can be elaborated to provide successively increasing levels of safety as time for preparation permits. I submit the following outline to illustrate an approach without any claim as to its originality:

Basic plan: Open an exit and get passengers out. Give or shout concise directions for use of other exits. Eliminate time losses at his or her station. Give directions for reduction of time losses at other exits. Select and instruct volunteers. Instruct passengers.

When there is no time for preparation, these instructions must be given by the member or members of the crew from his station while the evacuation is in process. For example, if an escape slide is immediately available for use, the attendant at the door could say: "Climb down, grab the red loops, and hold out the slide" and to the next passenger or passengers: "Help get the people out of the slide" or "help them get off the wings."

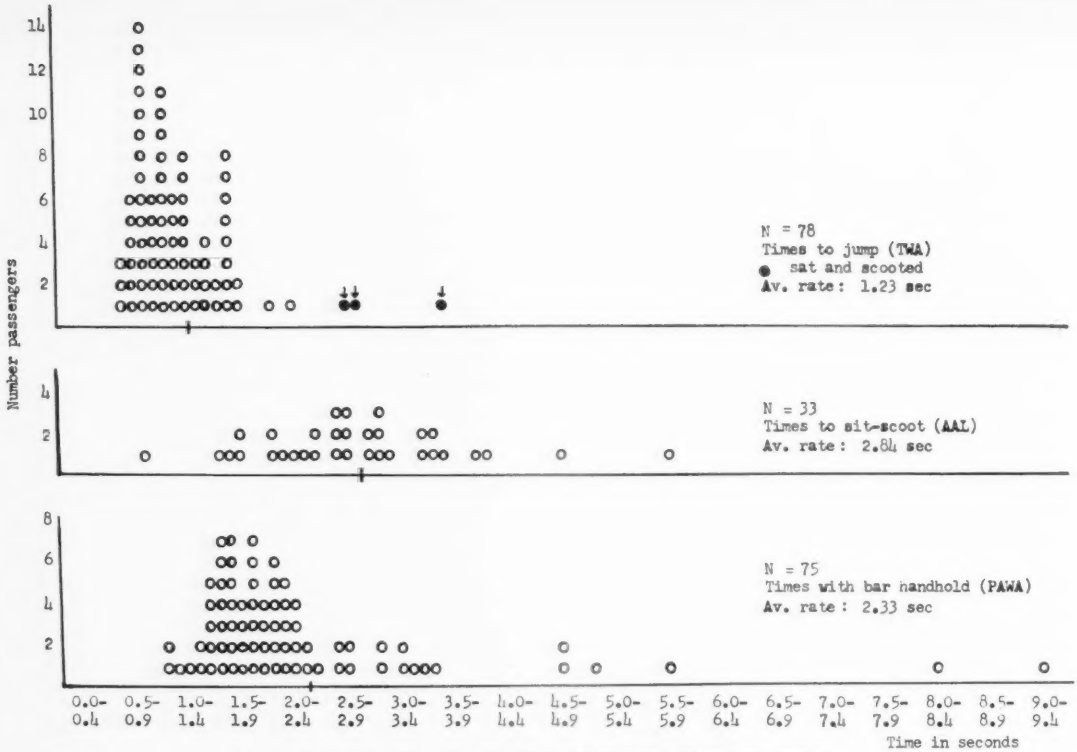
Escape Devices

The stair and inclined ramp are the most effective devices, because they fulfill the general specifications given in previous reports in that they (1) allow passengers to move forward and maintain a normal standing position and (2) permit use by several people at a time—i.e., they permit simultaneous occupancy. Compliance with a third specification—i.e., that it be self-supporting—will undoubtedly be attained in the near future, as you will hear from Air Cruisers.

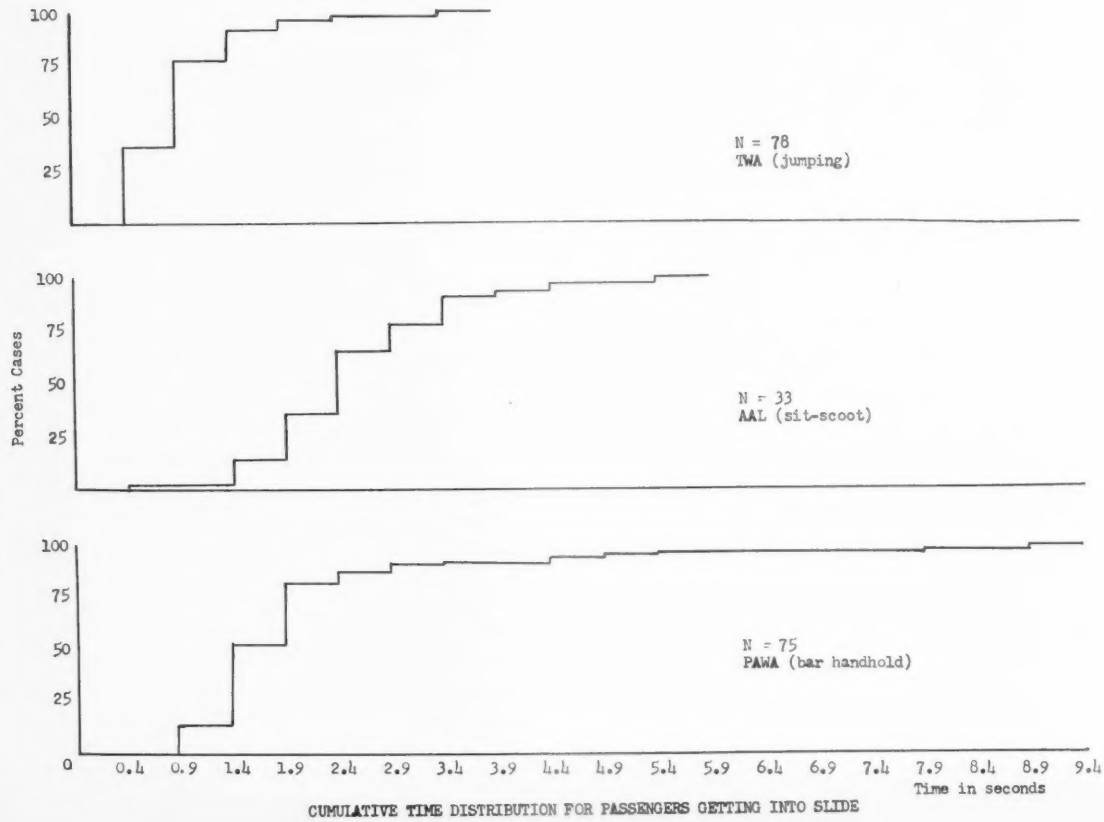
The next most useful device is the escape slide. This can be employed more effectively if the loops that provide for the proper angle of the slide are indicated by distinctive colors: one color designating the loops for use when there is a normal attitude in landing and another for use in the event of nose-gear collapse. A second improvement can be provided by tacking back the excess length of slide which is necessary only when the nose gear collapses. This would eliminate the need for folding back this length in normal landing attitude; the crew or volunteers holding the slide have enough to do. The difficulties in folding back the slide are well illustrated in the motion-picture records of all tests. The tacking should be such that it can be ripped easily if the excess length is needed.

Presented at the Air Safety Seminar of the Flight Safety Foundation, Inc., November 19–21, 1952, Bermuda.

* Research Executive, Medical Division.


Number passengers
N = 78
Times to jump (TWA)
● sat and scooted
Av. rate: 1.23 sec
N = 33
Times to sit-scoot (AAL)
Av. rate: 2.84 sec
N = 75
Times with bar handhold (PAWA)
Av. rate: 2.33 sec
0.0-0.4 0.5-0.9 1.0-1.4 1.5-1.9 2.0-2.4 2.5-2.9 3.0-3.4 3.5-3.9 4.0-4.4 4.5-4.9 5.0-5.4 5.5-5.9 6.0-6.4 6.5-6.9 7.0-7.4 7.5-7.9 8.0-8.4 8.5-8.9 9.0-9.4
Time in seconds

PASSENGER TIMES FOR GETTING INTO EMERGENCY EVACUATION SLIDE


Percent Cases
N = 78
TWA (jumping)
N = 33
AAL (sit-scoot)
N = 75
PAWA (bar handhold)
0.4 0.9 1.4 1.9 2.4 2.9 3.4 3.9 4.4 4.9 5.4 5.9 6.4 6.9 7.4 7.9 8.4 8.9 9.4
Time in seconds

CUMULATIVE TIME DISTRIBUTION FOR PASSENGERS GETTING INTO SLIDE

Fig. 1.

The importance of the colored loops and, hence, the proper angle is shown by results of the A.A.L. Convair tests. The volunteers held the slide at too gentle an angle in one test; in another it was held at 45°, the angle recommended by A.A.L. Average time required for sliding down the slide was reduced by slightly more than 38 per cent when it was held at the correct angle.

Over the Wing Exits

Proper use of wing exits can reduce egress time significantly. Passengers should get out using the "foot first, then the head" technic. Brief intelligible instructions are effective. We have observed that a succession of passengers "follow-the-leader" using his method. This succession is interrupted from time to time by an individualist; if he is successful, those following employ his technic. As an example, passenger improvisations such as stepping up on the seat as an "assist" in egress from window exits have been observed.

Where volunteers can be selected, they should be stationed next to their window exit station. If window arrangements are not the same (as in the Convair), the volunteer for the most difficult exit should be designated first. He should assist passengers out, tell healthy active individuals to "slide off and help passengers down," and serve as a "barker" to attract passengers to his exit at all times when it is not in use. The designated passenger ground assistants should work in pairs (face-to-face) to channel passengers off the wings in two or more lanes if there is a tendency to pile up on the wing.

These factors and others become apparent from analysis of time-study graphs such as are presented in the A.A.L. report. The other important causes of delay include periods during which exits are not used because of distribution and routing of passengers, difficulties with high heels, and the handling of children.

The arrangement of exits, including step-up-to-sill and step-down-to-wing distances, the orientation of major and minor dimensions, and the shape of exits also influence escape time.

Exits Not Over the Wings

These exits are suitable for healthy active subjects. Some involve a straight drop; they may or may not be equipped with ropes. In both cases it would appear that the best method is to put both feet and legs out, turn when sitting on the sill, and then drop; a rope is helpful in this situation. Exits near the wing fillet (as lounge exit in the Boeing 377 and rear exits of the DC-4) would be easier to get out of if a short rope, or hand-hold, such as a hand strap fixed to the inner face of the window frame, were provided.

Comparison of Relative Times for Getting into a Slide

Fig. 1 shows the relative time distributions for getting into an escape slide by (1) the method of sitting down on the cabin floor and "scooting" into the slide—i.e., the "sit-and-scoot" method of American Airlines, Inc.; (2) the bar hand-hold, which involves swinging under a horizontal bar into the slide (suggested by Eastern Air Lines, Inc., and first tried by Pan American World Airways, Inc.; and (3) the jump method as used by Trans World Airlines, Inc.

Distribution charts and the time-study graphs[3] provide means for comparative evaluation of exits, passenger-handling procedures, and descent devices. Time measurements show what can be done under test conditions, and serve as a basis for comparison and indication of relative improvement. The absolute time values for performance of comparable acts under true operating emergency conditions will probably range from somewhat shorter to significantly longer times depending upon the crew, the passengers, and the circumstances of the accident.

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Rearward- and Forward-Facing Seats

HUGH DE HAVEN*
Cornell University Medical College

MANY PEOPLE ASSUME that rearward-facing seats are safer than forward-facing seats. Their assumptions probably will be supported by reports from accidents.

(a) IF the seats are properly designed.

(b) IF the direction in which principal forces act in survivable transport accidents is such as to utilize the assumed safety features of rearward facing seats—i.e., if the crash force throws the head and body against the seatbacks.

(c) IF the force of survivable transport crashes is severe.

Rearward-facing seats will not provide marked safety advantages over forward-facing seats.

(a) IF the force of survivable transport crashes is not severe (in portions of cabin structure which remained reasonably intact).

(b) IF the direction of force in typical survivable transport crashes acts in many different directions.

(c) IF the design of rearward-facing seats does not include many of the safety features now built into forward-facing seats.

As things stand today, there are many "IF'S"—and far too little crashproof—to permit direct answers to questions currently being asked about safety in rearward-facing seats.

Basically, the idea of protection by strong aft-facing seats appears to be very good. Military groups have great faith in the idea; they are putting rearward-facing seats in several different types of transports.

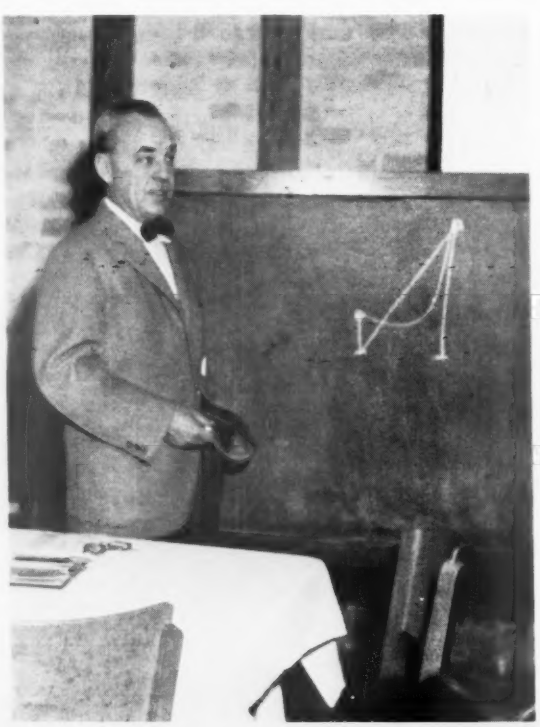
Air-line groups on the other hand feel, with some justification, that safety problems are different from those of troop transports. Comfort and appearance are important in civil air liners. Civilian passengers can be choosey about which way they sit. Also, in air-line operations, paved runways and elected weather minimums imply lesser safety problems than will be found in military transport operations in Alaska or at the North Pole.

These are only some of the reasons for believing that different considerations enter the problem of using rearward-facing seats in military and civil air transports. However, if rearward-facing seats are as good as is generally believed, they should prove their value within a relatively short space of time and provide useful safety information for consideration by air-line operators.

Designers of rearward-facing seat installations for military planes should go further than some of the early concepts of merely "beefing" up the seats and turning them around. Designers should bear in mind that people get flopped around in severe, survivable transport accidents. If they are held only by safety belts, it is more than likely they will be flailed around and can be seriously hurt by striking objects, whether they are sitting in forward-facing or rearward-facing seats.

In order to fully utilize the advantages of rearward-facing seats, military personnel should be equipped with some combination of safety belt and shoulder harness to hold them in their seats—against the seatbacks.

With regard to the possibility of air-line operators installing rearward-facing seats, I believe it is safe to say that no radical change in seating arrangement—or seat strength—will be undertaken by air-line operators simply on the basis that the idea seems good. Air-line operators are not satisfied with the supposition that rearward-facing seats are safer than forward-facing seats. They want specific information! Although there are good reasons to believe that rearward-facing



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* Director of Crash Injury Research. Cornell University Medical College.

seats will ultimately show a safety advantage over the best forward-facing seats, it is certainly reasonable at this time for air-line operators to ask: "What types of rearward-facing seats are safer than good forward-facing seats? How much safer are they—and in what percentage of accidents?"

Valid answers to these questions—as I see it—can only come when sufficient evidence is accumulated from a sufficient number of accidents to permit sound judgment.

So far, there have been few accidents in aircraft using rearward-facing seats. None has been reported by U.S. Navy, U.S. Air Force, or M.A.T.S. There have been four or five accidents in British aircraft. The Viking accident near Stockholm, for example, was a severe crash that seemed to justify, in every way, all that has been claimed for rearward-facing seats. There was also a questionably severe Hastings accident near Benina. There was a Hermes ditching near Sicily and a belly landing in France. The last three accidents did not provide strong evidence for answering current questions.

Against these few accidents for judging the effectiveness of rearward-facing seats, at least nine accidents in U.S. civil air transports come readily to mind and, in all of these, forward-facing seats and strong safety belts gave satisfactory degrees of protection; in some of these cases the degree of safety was surprising. Most of you will recall the DC-4 at Philadelphia which overran the runway; the Convair 240, which flew into the water at Kingston, Jamaica; the DC-6, which crashed on take-off at Mexico City; and the Convair 240 at Tulsa, Okla. In all of these, there were virtually no crash injuries.

In the C-46 at Little Valley, N.Y., the aircraft disintegrated, with the exception of the aft part of the cabin, and all seats but one tore out. Yet, there were 14 survivors. Also, in the Martin 202 crash, at Tucumcari, N.M., the airplane broke into three parts and was extensively damaged. Of the 26 passengers, one was fatally injured, three were reported to have had serious injuries, and the remainder was reported to have minor or no injuries. The Northeast Convair 240 accident, which struck the water near LaGuardia, resulted in limited injury for three passengers. The American Airline's Convair accident, near Memphis, resulted in serious injury for some of the passengers. In this accident there appears to have been justification for believing that rearward-facing seats would have modified the exposure of passengers to injury.

Most astonishing of all was the National DC-6 accident at Elizabeth, N.J. This crash was exceedingly violent and resulted in an almost total disintegration of the plane and passenger cabin. Yet, 50 per cent of the passengers survived.

Facing the facts, in the recent accidents in scheduled U.S. air liners, we find little evidence that rearward-facing seats would have made a significant difference in passenger safety. Perhaps this sample of accidents, in the parlance of statisticians, is "unique." Perhaps it is valid. What this group of accidents appears to indicate is that crash forces that break up basic structures of large transport aircraft—in survivable accidents—are not so severe as is generally believed. Although jolt loads on safety belts may be in the order of 15*g* to 20*g*, the mean force of crash decelerations in sections of the large aircraft, which remain intact, may be in the order of 10*g*, 5*g*, or less.

If this is true, it is quite possible that good forward-facing seats will take care of passengers in all but a small percentage of unusually severe incidents. Certainly the score, as it stands today, does not suggest that rearward-facing seats would materially increase passenger protection in the types of survivable accidents in which U.S. civil air liners have been involved.

Possibly, during the coming year, we will get radical departures from current evidence on both rearward-facing and forward-facing seats. It is certain that ultimate decisions on the relative merits of each type of seat should be weighed against a larger volume of evidence than is available today.

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The H FACTOR in Engineering Design*

CLIFFORD SEITZ,† U.S. Navy Special Devices Center

IF WE EXAMINED the modern hammer, I think we would find its weight, handle length and diameter, and other dimensions are fairly standard. If we then undertook a study to determine the "best" dimensions for a hammer, we would probably find the present hammer just about what it should be.

There's no doubt about it—the hammer is well designed. But how did it happen? It all happened a long time ago when a man designed the first hammer for his own use; later he made hammers for other men, and then he discovered that the hammer that suited him wasn't acceptable to others. Through a process of trial and error, through experience, and by evolution, a hammer suitable to the needs of many men was designed. This process of design by evolution can apparently produce a reasonably well-designed product, but it costs a lot in time.

We are obviously eager to telescope the evolutionary process, and so some people have concerned themselves with the Human or H Factor in engineering design.[1-6] Some of us know that considering the H Factor helps us to design much better equipment. We feel that the Human Factor is so important that we want our fellow engineers also to use this knowledge. But somehow and for some reason most of them don't. We want to point out what we think stops engineers from systematically considering the Human Factor and show how these barriers can be removed.

There are many reasons why the Human Factor is not systematically used. The most important seems to be that, as in the case of the first hammer, the Human Factor is considered and is thought of as common sense.

After all, engineers are men and know something about other men. They, of course, recognize that men are different—that some are taller, stronger, and quicker than others—but they seldom realize how big these differences are and how many and subtle they can be. They see the differences in terms of their experiences with men much like themselves, not in terms of the universe of men. The hammer suits them—it may suit their engineering friends, but it takes a century or more to suit the universe.

The fact that most men feel equipped to deal with the problems of other men has plagued medicine, psychology, education, psychiatry, etc., for generations past.

The common-sense variety of Human Engineering is handicapped, in addition, because it is casual: there is no preplanning—no systematic study of goals. It's a matter of chance if the Human Factor is accounted for, and the results are seldom predictable and generalizable.

We often hear that the H Factor is not applied because there isn't enough data or that Human Engineers write reports nobody else can read. These are criticisms that cannot be tossed aside. Human Factor data are limited, yet we think you will agree that, if we used the information we now have, we would be taking 7-league steps. We hold no brief for poor writing, yet it seems apparent that engineers regularly use and manipulate information more abstract than that reported by Human Engineers. We think the casual common-sense variety of Human Engineering sets up this barrier.

Another reason for not using the Human Factor is said to be the lack of Human Engineers. There don't seem to be enough Human Engineers. It's our guess, however, that, if there were very many more, some would be unemployed because, on the basis of the "common-sense" hypothesis, engineers can do the job unassisted. We might also observe that in all probability, if the Human Factor is to be systematically applied, it will be done by engineers in association with a small number of professional Human Engineers.

It's apparent the engineers need more Human Engineering help, but it's also clear that they won't buy help they see no need for. The problem therefore is to make it possible for engineers to know more about the Human Factor; to appreciate the wide range and reserve of performance; and to recognize that elusive

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* The observations in this report are those of the author and do not necessarily reflect the position of the Special Devices Center, the Office of Naval Research, or the Department of the Navy.

† Head, Program Branch, and Deputy Director, Human Engineering Division.

factors such as personality and morale can make a big difference, or, for example, that in a man-machine system the errors contributed by each accumulate as the sum of the squares of the errors.[5, 7]

Our discussion seems to boil down to just one thing—engineers need more knowledge about the Human Factor without at the same time becoming Human Engineers. We think that there are short- and long-range plans that will meet this goal. The *short-range plan* requires that the organizations and men who recognize the importance of the Human Factor insist on writing Human Engineering requirements into specifications. The Research Development Board panel on Human Engineering and Psychophysiology[8] has made such a recommendation. If such contracts are written, the contractor can afford to employ Human Engineering talent and orient his engineers to the Human Factor in engineering design. The staff will have an opportunity to learn through exposure, and the product should be more competitive.

The *long-range plan* is based on the assumption that Human Engineering is a subject relevant to engineering and psychological training. We propose, therefore, that Human Engineering become a subject for the engineering and psychology curriculum, that graduate courses be offered, and that scholarships and awards be made to engineers and human engineers in support of additional training and in recognition of their contribution to Human Engineering. We also believe that industry should support an exchange program. Young engineers interested in the Human Factor should be sent to a university or an industrial Human Engineering concern for a year, and in exchange a Human Engineer should be farmed out to industry.

The use of the industrial internship or planned program for the growth of staff is common practice in many companies and has inestimable benefits to employer and employee alike.

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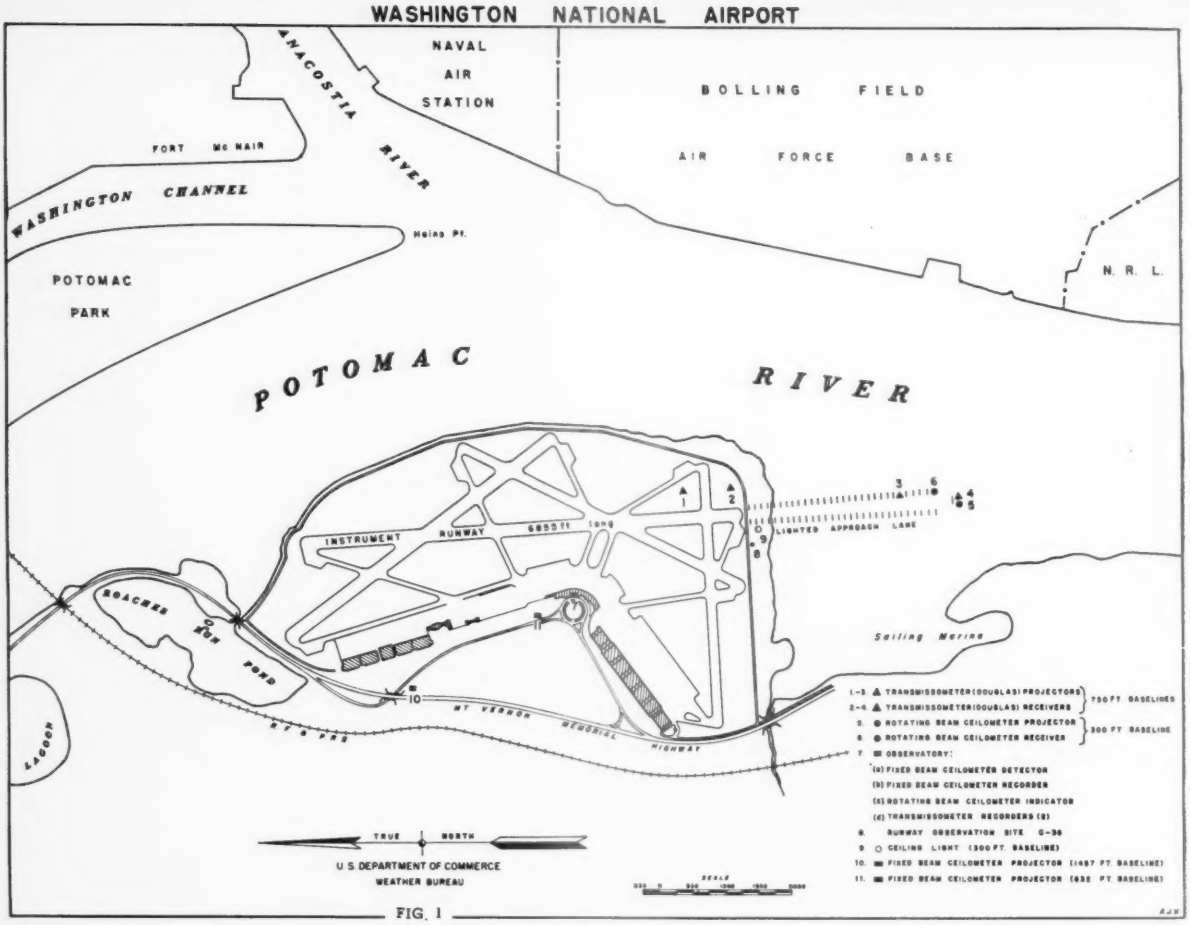

FIG. 1

Final Approach Visibility Studies at Airports in the United States

*B. C. Haynes**

U.S. Weather Bureau

Introduction

For a number of years, the Weather Bureau has been engaged in studies of instruments and observational techniques for improved reporting of ceiling and visibility conditions at airports. This work has been accelerated in the last year by the active support given to the Weather Bureau by the Air Navigation Development Board.

The first series of investigations was designed to provide a comparison of cloud-height indications given by the pulsed-light cloud-range meter, regular fixed-beam ceilometer, the rotating-beam ceilometer recently developed by the Weather Bureau, the ceiling projector-clinometer system, and visual measurements using tethered and free balloons. In addition, comparative visual-range observations are being made by an observer near the end of the instrument runway with indications of a transmissometer. These comparisons, for the most part, are being conducted at the Washington National Airport and at the Weather Bureau's Silver Hill Observatory near Washington. The objective of this phase of the program is to develop automatic instrumental equipment and observational techniques for measuring ceiling and visibility conditions at remote locations along the glide path of an instrument runway and along the runway in the landing area.

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Television was also investigated as an aid in determining visibility by remote methods, a television camera being placed near the end of the runway and television receivers being located in the control tower and main weather observatory.

Beginning December 15, 1952, end-of-the-runway observations at Washington National Airport (See Fig. 1) will be available. These observations will be made by means of the new rotating-beam ceilometer at the middle marker, a transmissometer at the middle marker, and a transmissometer near the touch-down area of the instrument runway.

The Air Navigation Development Board has contracted with the Sperry Gyroscope Company to conduct a low-ceiling-visibility program at MacArthur Airport, Long Island. The U.S. Weather Bureau will cooperate in the program at MacArthur Airport by providing meteorological guidance and installing the necessary instrumental equipment. The Sperry Gyroscope Company, using a fully instrumented DC-3 aircraft, will fly approximately 1,000 I.L.S. approaches under low-visibility and low-ceiling conditions. Data will be compiled and reduced to analysis form so that (a) weather observations made by U.S. Weather Bureau instrumentation may be correlated with visibility observations made from the aircraft during I.L.S. approaches and (b) analysis of these data may be related to approach success and approach hazards.

Reports of the Weather Bureau's work, as well as that of the Sperry Gyroscope Company, will be prepared periodically for the Air Navigation Development Board.

Instrumentation

Transmissometer.—A transmissometer is an instrument that measures the transmission of light through the atmosphere. The transmissometers used at the airport, developed by Douglas of the National Bureau of Standards, consist of three basic units—namely, a projector, a receiver, and an indicator-recorder (see Fig. 2). The projector and the detector are field installations set up to measure the light transmission along a fixed path between the two units; the indicator-recorder can be remotely installed at any convenient location. The projector emits light of constant intensity toward the photoelectric-cell receiver. The length of the base line between the two units defines the reference dimension of the air sample through which the transmission is measured. At the receiver, electrical pulses are generated at a rate proportional to the illumination from the light source impinging on the photoelectric cell. Following amplification of the signal, the pulse rate and, hence, the extinction coefficient (or transmissivity) characterizing the air path between the light source and the photoelectric receiver can be measured and recorded.

The projector uses a sealed reflector spot lamp with a 100-watt, 6-volt, C-6-type shielded filament. The lamp is on continuously and is expected to have a service life of from 3 to 6 months. A voltage regulator is installed to stabilize the operating voltage and eliminate fluctuations that would affect the light-source intensity. A step switch in the regulator circuit permits the overall adjustment of the operating voltage.

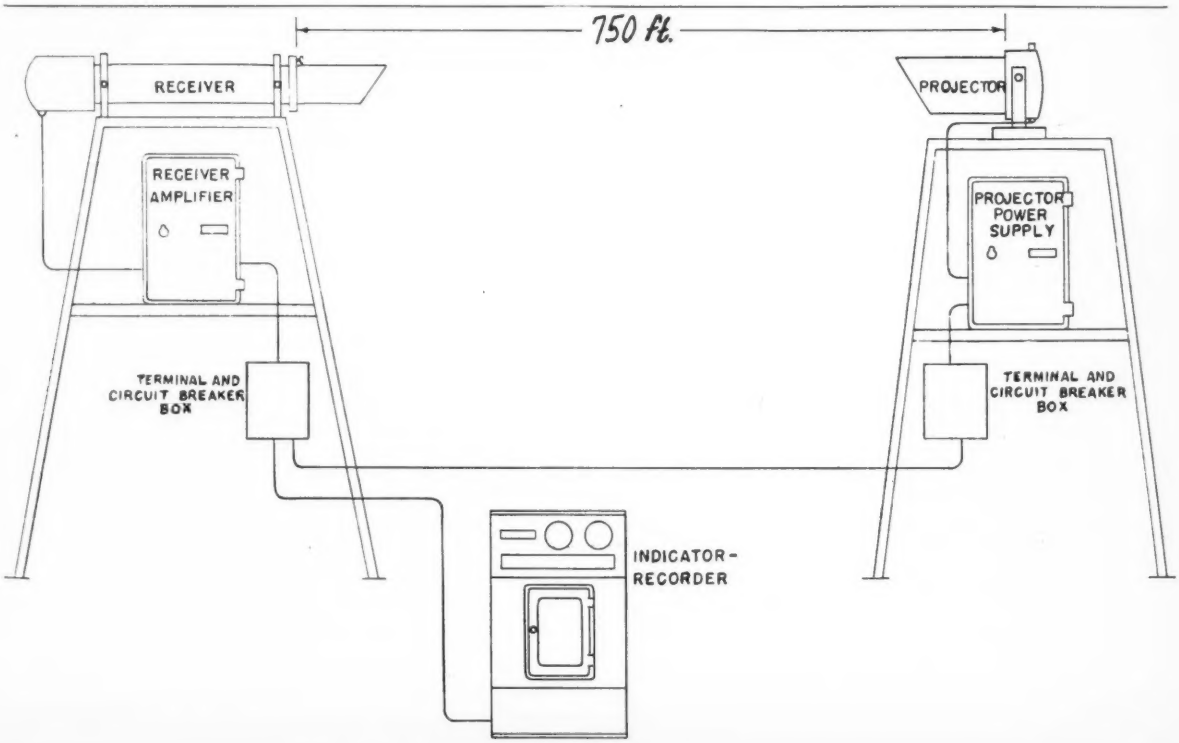
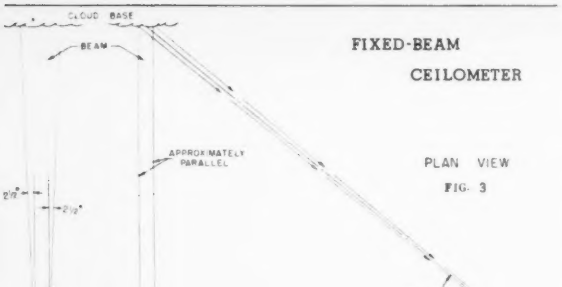


Fig. 2. Transmissometer layout.



Principal components of the receiver are a photoelectric detector and an amplifier. The detector is mounted in a metal barrel that also contains a lens system and a diaphragm. The lens system and the diaphragm provide a fine adjustment of the amount of light incident upon the cell. Light falling upon the photoelectric cell generates current within the cell. The current is discharged as a pulse through the amplifier. The frequency of these pulses is directly proportional to the amount of light received (illuminance). These pulses are amplified (see Fig. 2) and transmitted over a signal line to the indicator.

The indicator consists of a two-stage amplifier, a frequency-measuring network, and a calibration circuit. The amplifier sharpens and amplifies the pulses and reduces the effect of noise picked up on the transmission line. The frequency meter levels and averages the pulses and produces a meter reading that is directly proportional to the pulse frequency and, therefore, directly proportional to the transmissivity of the atmosphere between the light source and the receiver. A calibration circuit provides the means of applying a known fixed frequency through the amplifier in place of the normal incoming pulse signal from the receiver. The standard 60-cycle power-line frequency is conveniently used for this purpose, and, with this frequency applied, the meter is adjusted for proper deflection.

The recorder is a standard milliammeter type calibrated to the same scale as the output meter on the indicator. A continuous graphic record is made of the transmissivity measurement taken by the equipment.

By means of appropriate conversion charts or tables, the transmissivity may be converted to the corresponding visual range of a standard black target during daylight conditions or of a point source of light of standard intensity (25 candles) during nighttime conditions.

Fixed-Beam Ceilometer.—The fixed-beam ceilometer consists of three major components—a projector, a detector, and a recorder. The general layout of the equipment is shown in Fig. 3. When the ceilometer is in operation, a photoelectric detector scans a vertically projected light beam. The detector is activated when it receives light reflected in its direction by cloud droplets within the beam. With a cloud deck present, the amount of scattered light received usually increases from zero to a maximum value and then decreases again to zero as the field of view of the detector moves across the illuminated portion of the cloud. The electrical impulses from the detector are amplified and relayed to a chart recorder. The length of base line and the elevation angle at which the maximum reflection is detected make it possible to calculate the height of the reflective areas by triangulation.

The projector consists of a mercury-vapor quartz-tube lamp, about 1 $^3/_4$ in. long and $^1/_4$ in. in diameter, backed by a 24-in. parabolic mirror. This lamp, rated at approximately 20,000,000 peak candle power, operates at an extremely high temperature and must be cooled by two air jets. The projector beam is modulated at a frequency of 120 cycles per sec., in order that the detector may discriminate between light from the projector beam and any other incident light, such as general sky brightness, aircraft landing light, etc. During operation of the lamp from a 60-cycle a.c. source, the necessary selective light-beam modulation of 120 cycles per sec. is produced by the mercury lamp itself.

The detector of the ceilometer consists essentially of a photoelectric cell with an appropriate lens system mounted in a metal tube that is pivoted to swing through an arc from the horizontal to the vertical (see Fig. 3). A synchronous electric motor drives the tube in a continuous up-and-down scan along the projector beam. The full cycle requires about 12 min. A selsyn motor connected to the scan drive transmits the angular position of the scanner to a remote chart recorder. The detector amplifier is activated whenever the photocell tube scans a bright space in the cloud consisting of cloud droplets that are illuminated by the projector beam and scatter light toward the receiver. The response of the photoelectric cell is amplified and channeled through a discriminator circuit tuned to the selective modulation frequency of the projector beam. The signal is further amplified and fed either to a microammeter or a recorder-amplifier.

The relative magnitude of the illumination owing to scattered light emanating from the projector beam is traced by the recorder as a function of the corresponding elevation angle of the detector. The recorder is also calibrated to show the respective heights above a specified reference plane pertaining to the various elevation angles.

Rotating-Beam Ceilometer.—The Instrument Division of the U.S. Weather Bureau has developed a rotating-beam ceilometer system that is now undergoing tests at Washington National Airport and Silver Hill Observatory.

This system (Fig. 4) employs the triangulation principle and consists of three major components—pro-

jector, detector, and indicator. The design differs radically from the ceilometer equipment now in general use by the Weather Bureau in that the projector beam, instead of being pointed to the zenith, is rotated continuously in the vertical plane of the detector. The detector, instead of scanning from the horizon to the zenith, is permanently fixed to view the zenith at all times. The detector receives, within its field of view, scattered light from cloud droplets that are illuminated by the beam from the projector. When a cloud deck is over the system, the intensity of the illumination usually increases from zero to a maximum and then decreases to zero as the projector rotates. The elevation angle of the projector corresponding to the maximum of the scattered light received by the detector depends upon the height of the cloud base and upon the cloud structure.

The projector comprises a 240-watt, high-current incandescent lamp mounted at the focus of a 24-in. parabolic mirror. The mirror and lamp are contained in a drum supported on horizontal trunnions. A synchronous motor rotates the drum at 2.5 r.p.m., or once every 24 sec. A barrel shutter, driven by a synchronous motor, is mounted in the drum so that the light collected by the mirror from the incandescent lamp is interrupted at a rate of 120 times per sec. This modulates the flux of the light beam, making it possible for the detector to identify scattered light that originated at the projector.

The detector consists of a lead-sulfide photoconductive cell mounted at the focus of a 24-in. parabolic mirror. The output of this cell is fed into a high-gain audio amplifier, the output of which is peaked at a frequency of 120 cycles per sec. with a bandwidth of 10 cycles. An infrared filter is interposed between the mirror and the cell. This serves to reduce the attenuation and background "noise" effect produced by scatter from air particles smaller than cloud droplets and to reduce the light flux incident upon the cell in order to maintain the flux at a level consistent with the maximum sensitivity of the cell.

One type of indicator comprises a 5-in. cathode-ray tube, synchronous motor, and associated electronic circuits. The circuits and mechanical design are such that the spot of the cathode-ray tube makes four circular traverses around the center of the tube screen for each revolution of the projector drum. The signal intensity from the detector is indicated by radial deflection of the cathode-ray-tube spot from this "no-signal" circle. A circular height scale is fixed on the periphery of the cathode-ray-tube screen. A signal from the detector deflects the cathode-ray-tube spot from the "no-signal" circle toward the graduations on the peripheral scale, so that the height at which the modulated illumination of the cloud originates can be read. A recently developed indicator utilizes a 12-in. cathode-ray tube with circuit modifications that permit the ray to sweep the center of the tube vertically

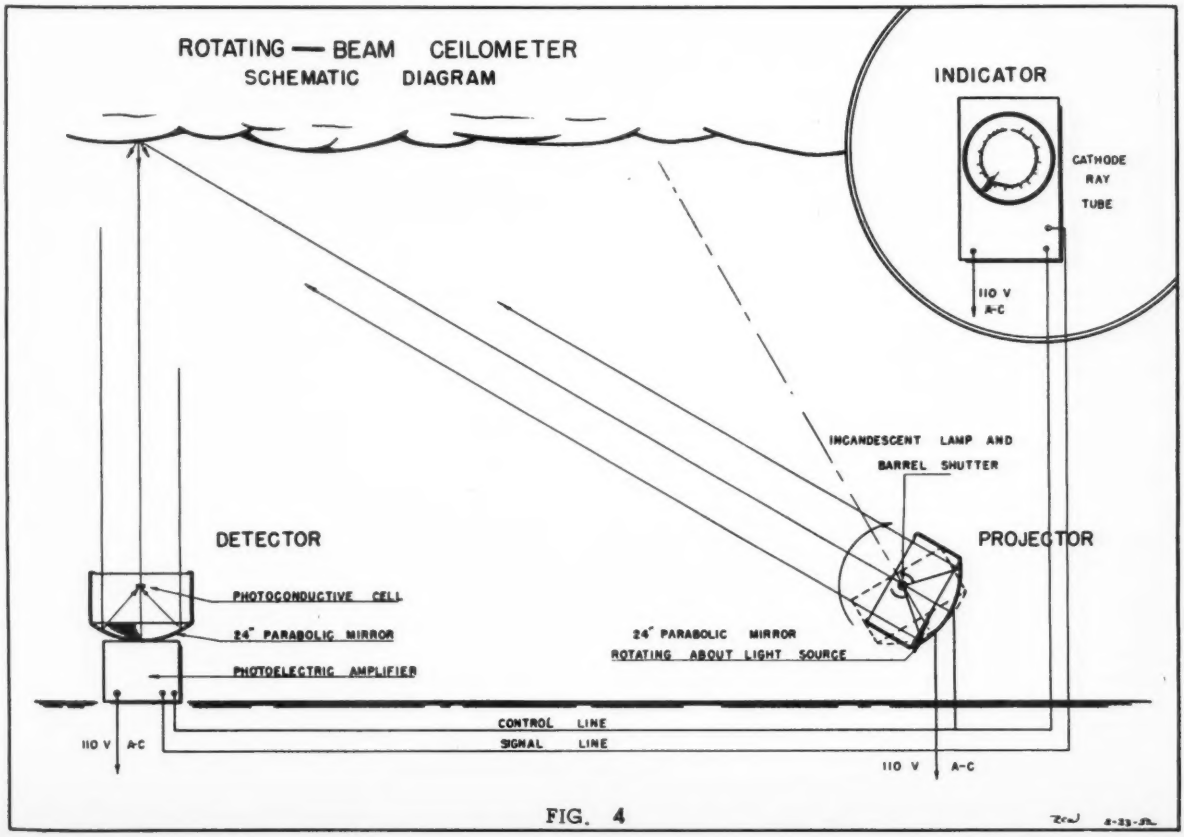


FIG. 4

rather than in a circle. The cloud-height indication is thereby presented on a vertical scale rather than on a circular one as in the previous model. The long persistence of the image on both types of tubes plus the rapid rotation of the projector maintain an almost continuous presentation. Synchronization between the motors driving the projector and indicator is obtained through a pulse that appears at the output of the detector when the projector beam strikes a small target situated immediately over the cover glass of the detector. To place the indicator in service the cathode-ray-tube spot is manually positioned to the zero point of the cloud-height scale. Synchronization is effected when the pulse from the projector actuates the starting relay of the indicator drive motor. Since both motors are of the synchronous type, they will stay in phase as long as both are energized.

This system of transmitting the angular position of the projector drum to the indicator eliminates the multiple circuits that would be required if a synchro (selsyn) system were employed. Hence, with power at the projector and detector sites, the only wiring required is a two-wire telephone signal line between the indicator and detector and a similar control line between the indicator and projector. This arrangement permits placing the projector and detector many miles from the weather observatory without the use of expensive multiconductor cables. Moreover, this scheme permits the use of simple V.H.F. equipment as a connecting link between the components of the system.

General Electric Pulsed-Light Cloud-Range Meter.—The cloud-range meter is a device intended to measure the height of clouds between 500 and 5,000 ft. from the point of observation. A narrow beam of short, intense pulses of light is directed at the cloud in question, and a small portion is reflected to the receiving equipment. The time interval required for each pulse of light to travel to and from the cloud is measured as an indication of range. The equipment consists of two main components—a transceiver and a control unit with an oscilloscope.

The transceiver consists of two 18-in. parabolic mirror units mounted in cylindrical drums positioned beside each other in a rotatable yoke. One unit houses the transmitter, and the other the receiver. In the transmitter, a pair of electrodes mounted in a special spark-discharge circuit produces the transmitted light pulses. The electrodes are oriented at the focus of the mirror to provide a narrow beam of intense light. A phototube in the transmitter housing picks up the transmitted light pulses, which are relayed to the oscilloscope where they are used for calibration and synchronization. Another phototube is mounted at the focus of the receiving mirror, where it picks up any returning pulses of light which may be reflected by a target such as a cloud. These pulses are amplified and fed to the control unit where they are shown as a vertical deflection or pip on the scanning beam of the oscilloscope. When the unit is properly adjusted, the center of this pip, with reference to the calibration scale on the face of the cathode-ray tube, gives the range to the reflecting object. The vertical height of the reflected object is equal to the range times the sine of the elevation angle of the transceiver.

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Predictive Diagnosis

(*Concluded from page 31*)

stances into a patient may alter the course of many now incurable diseases.

The vast majority of testing done today is not in any sense predictive but is rather a measure of disease. When we examine a pilot and state that he has a certain disease—let us use anemia as an example—we are saying that a certain set of circumstances and factors existed yesterday, a month ago, a year ago, which now result in a low red blood count. What we are striving for is to determine what factors were introduced since the last physical examination which, when put together, resulted in the anemia. If we could examine an individual's blood or heart and determine that factor A, B, or C is abnormal and be able to correct this prior to the actual development of the disease, we would arrive at the pinnacle of successful medicine. This is the aim of all physicians, whether engaged in Aviation Medicine, general practice, or one of the many specialities.

A Review of the Problem of

EXTERNAL AIRCRAFT NOISE

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(I) Introduction

MANY RECENT EVENTS have directly or indirectly highlighted the problem of noise from aircraft, both in flight and during ground maneuvers. The problem is now recognized as one of major importance to the aeronautical world. Although a few years ago the problem was considered to be one of relative simplicity in comparison with others that had not been adequately solved, it can now be shown to possess aspects of great difficulty, a fact resulting from the complexity of the several pertinent factors, when separately considered, as well as the difficulty of solution of the problem as a whole. In this paper, the factors will be brought out in some logical form and the difficulties experienced in coping with them will be noted, even though promising solutions are not evident in many cases. In other words, the problem is complex, and here is why.

(II) Discussion

Broadly considered, the problem of external aircraft noise separates into six important subdivisions, all interrelated. These subdivisions touch many fields, including the physics of sound, measurement and instrumentation, psychology, sociology, operations, economics, and others. Although the fields are diverse, the interrelation is such that the overall picture is found to be extremely comp'ex.

In Table 1 are listed the six subdivisions that are required to embrace completely the problem of control of the external sound of aircraft. The list can probably be expanded, but I doubt if it can be curtailed. Examination of the list quickly discloses that the industry may be said to have "a bear by the tail." The six subdivisions are discussed individually.

(A) *The Physics of Sound*

Because the physical properties of sound have been well understood for some time and because adequate techniques for their measurement and evaluation, even in their most complex forms, are available, the aircraft industry's concern over the physical considerations probably need be less serious than is the case for any of the five factors.

As is well known, sound is generally defined in terms of vibrations in the air in a range of amplitude and frequency to which the human ear is responsive. Only when they are relatively loud at the point where the listener hears them are sounds likely to be objectionable; other sounds, if of concern at all, are important for other reasons than intolerability of the disconcerting effect of intensity.

It is unfortunate perhaps that all powered aircraft, both jet and propeller types, are in effect a form of "siren." The siren is a device constructed of rotating paddles or blades operating in a moving air stream in such a way that the air is modulated. When man wants to construct a sound source capable of being of high intensity on a continuing basis (i.e., other than an explosion), he has found the siren superior to any other device. Well-known applications of this include, of course, the police siren, the fire siren, and the air-raid siren. Unfortunately, equivalent examples are the rotating propeller of an airplane or the compressor in a turbojet engine. In the case of the turboprop, we have the siren elements of both the jet compressor and the propeller! It is not surprising then to find we have Grade-A noisemakers in our skies!

Physical characteristics of sound include considerations of intensity and of frequency (or spectral) components. The intensity consideration is more or less self-evident, whereas the concept of frequency components is less obvious. A so-called "pure tone," as a tone from a tuning fork, consists essentially of a single frequency component, whereas most of the sounds we hear contain many components. Sounds that contain a large number of frequencies are usually referred to as possessing the characteristic of a "broad band spectrum." The needle scratch on an old-fashioned phonograph record is a good illustration of such. The noise of a tire as it scrapes the runway when an aircraft touches down is another example. Many sounds contain discrete frequency bands of energy, with each band possessing the characteristic of a broad band spectrum. An example of this might be the exhaust of a reciprocating engine or the whine of gear teeth. Meas-

Table 1
The Six Facets of Aircraft Noise Problems

(1) Physical Measurement
(2) The Ear as a Detector
(3) Psychological Considerations
(4) Mass Psychology
(5) Politics
(6) Economics

Presented at the Air Safety Seminar of the Flight Safety Foundation, Inc., November 19–21, 1952, Bermuda.

* Staff Scientist

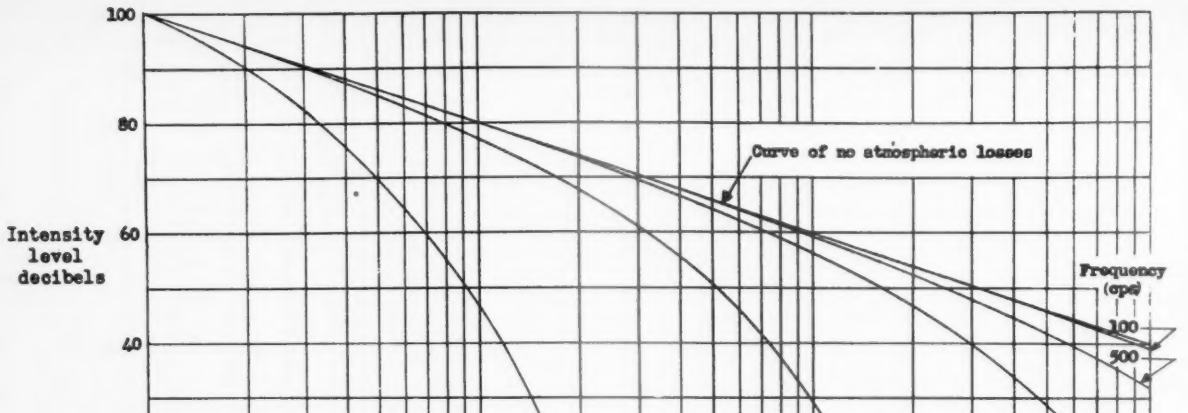

FIG. 1. Sound pressure level as function of distance from source calculated for 40 per cent humidity and 68°F.

urement of amplitude and frequency characteristics of sounds results in information on their power spectrum.

Having set the stage with comments on the nature of sound, methods whereby it is measured for physical evaluation, and its position as a problem to the aircraft industry, it is next appropriate to review some of the known means for controlling sound.

The intensity of wave energy, when radiating spherically in free space, tends to become weaker in inverse proportion to the square of the distance from the center of curvature of the wave. This is the well-known inverse square law, and, when it applies, the intensity is reduced by a factor of 4 if one doubles the distance of the observation point from the center of curvature of the spherical wave front; or, similarly, if one multiplies the distance by 100, the sound is reduced by a factor of 10,000. The relation is conveniently illustrated by the top (straight line) curve in Fig. 1, where the abcissa is distance from the sound source in feet, and the ordinate is sound power in decibels. Thus, distance is one of the most important factors in sound control in aeronautical work.

The inverse square law holds very well for low frequencies (up to a few hundred cycles), but additional attenuation results from air damping at the higher frequencies. For instance, in Fig. 1, the combined attenuation effect of the inverse square law and the effect of air damping is seen to be of moderate importance at 1,000 cycles and to be profound at 10,000 cycles. These plotted data were computed for a relative humidity of 40 per cent, and they vary somewhat with humidity. Experimental verification has been accomplished.

Like nearly all other sources of sound, an airplane does not radiate the same amount of sound energy in all directions. Fig. 2 shows the pattern of the directivity of sound radiating from a typical jet aircraft. Notice that as one moves around the airplane the sound observed varies in level by a factor of 10 to 1 or more. Similar considerations apply to rotation around the aircraft in the vertical plane, as would be the case when the aircraft passed overhead. Unfortunately, it is hardly feasible to utilize this directive effect to solve the aircraft noise problem, because it is generally not practical to control the orientation of the aircraft producing the noise.

One naturally thinks of the possibility of improving the noise situation by reducing the amount of sound radiated from the aircraft. This hope is extremely difficult to realize because, in general, improvement can only be secured at a penalty in aircraft performance (i.e., speed, pay load, fuel efficiency, etc.). N.A.C.A. has done a great deal of good work in studying means of securing this type of improvement, particularly in the field of propeller aircraft. It is hoped that some advantage may ultimately be gained in this direction, although I quote H. H. Hubbard, of N.A.C.A., when I state that no easy and inexpensive solution to the aircraft noise problem is available at present.

It is known that barriers can be helpful in reducing aircraft noise but only under specific circumstances. The British have successfully employed a 40-ft. wall for this purpose; it is used to shield the aircraft on the ground during warm-up and test procedures, but they do not hold much hope for the operational value of such a method. Other barriers, such as natural hills, walls of buildings, and the like, are known to be helpful, as may be the presence of copious quantities of trees, grass, or loose, open sandy soil, in specific cases.

Diffusion of sound by turbulent air, and the tendency of winds to interfere with direct sound transmission are well-known factors, but control of these is hardly a hopeful possibility, nor is the effectiveness great enough to be of significance in most cases.

(B) *The Ear as a Detector*

If the above discussion of the physical consideration of sound seems complex and not too hopeful, such is not the impression I intended to convey. Science has well explored the problems of measuring, correlating, and evaluating sound in essentially all of its physical aspects, and if we could stop there, a complete and concise analysis of the problem would be at hand. Unfortunately, when the other five factors are added, the problem really becomes abstruse.

Considerations of the ear as a detector of sound are complex. For instance, in Fig. 3 is shown a plot of the hearing characteristics of the normal human ear; these data are the result of extensive pioneering work by Dr. Harvey Fletcher and his associates of the Bell Telephone Laboratories. The abscissa is indexed in cycles per second, plotted on a logarithmic basis, and the ordinate is intensity level of sound, also plotted on a logarithmic basis (decibels). The curves represent contours of sound levels of pure tones which produce equal feeling of loudness as frequency is varied.

This plot conveniently utilizes logarithmic scales both frequency-wise and intensity-wise because of the tremendous dynamic range of the human ear. For instance, the frequency response capability for persons with acute hearing may cover as much as 9 or 10 octaves of the frequency spectrum. Notice also the range of intensity over which the ear is responsive. In the middle of the audible frequency range the coverage is seen to be 120 db., or, on conversion to corresponding sound pressure levels, the response covers a pressure range of 10^6 to 1. More impressive is conversion to the equivalent range of power levels, where we find the ear responsive over a range of 10^{12} to 1. This is truly a fabulous range of operation for a detecting device! No wonder a logarithmic scale like the decibel is required for studying hearing!

That this tremendous range may be a blessing in ordinary living is fairly evident. However, when it comes to the problem of the control of noise for the assurance of human comfort and efficiency, the range may well be a curse.

(C) *Psychological Considerations*

If sound control is made difficult by the high performance, sensitivity, and versatility of the human ear, the situation gets worse when we add psychological considerations.

Things really begin to become complex and difficult when we start to take account of how that fantastic mechanism, the human mind, reacts to sounds, both wanted and unwanted, detected over tremendous ranges of frequency and intensity, and sounds com-

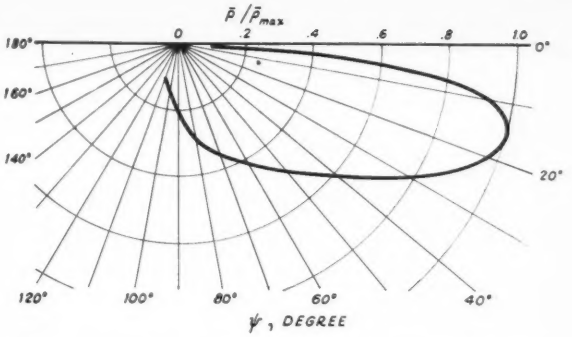

FIG. 2. Representative sound distribution pattern for a jet aircraft.

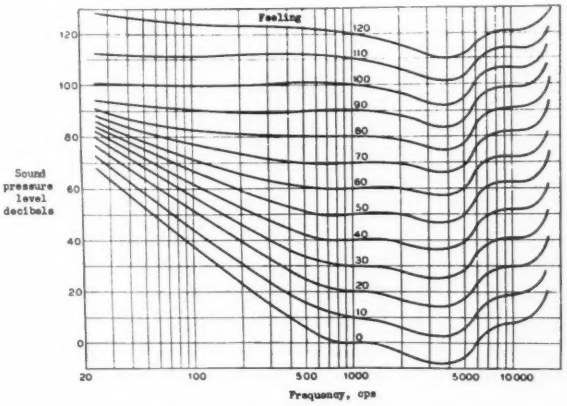

FIG. 3. Loudness-level contours.

posed of various combinations of frequency elements whose intensity is modulated in a wide variety of fashions.

Subsequent to the work at the Bell Telephone Laboratories under Fletcher, the problem has been studied on a continuing basis by Beranek at M.I.T., Mintz and Tyzzer at the Armour Research Foundation, and others.

Fletcher developed techniques for evaluating the subjective reaction to single pure tones covering a wide range of frequencies, and this is what we were observing in Fig. 3. These data are inadequate, however, for general applications involving sound control because most offending sounds are not pure tones. A method suggested by Beranek has been worked out for quantitative evaluation of the subjective importance of complex tones. The method consists of four steps: (1) determination of the sound pressure level in some eight octave-wide frequency bands distributed across the audible spectrum; (2) plotting the octave band levels on the special graph paper shown in Fig. 4; (3) reading from the graph the loudness for each octave band; and (4) summing the results to obtain the total loudness.

This is not a course in the use of the loudness chart in the solution of specific problems. Rather, I am endeavoring to display for everyone's consideration the

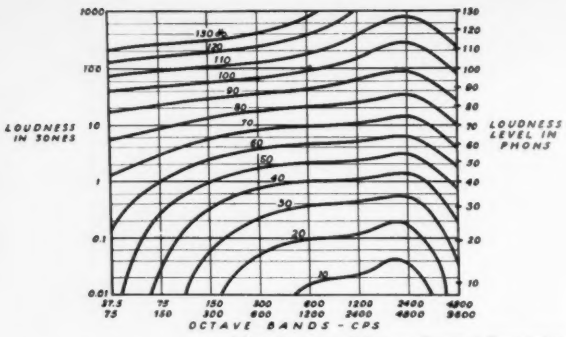

Photo Courtesy of Armour Research Foundation

FIG. 4. Loudness chart for octave-band measurements of complex sounds.

TABLE 2
Representative Values of Typical Sounds

Sound Level, Db.	Typical Sounds
140	Aircraft engine test cell
130	Threshold of painful sound
120	Auto horn at 3 ft.
110	Boiler factory
100	Elevated train overhead
90	Noisy factory
80	Noisy restaurant
70	Average speech at 3 ft.
60	Quiet residential street
50	Quiet office
40	Average quiet dwelling
30	
20	Rustle of leaves
10	Average threshold of hearing
0	Threshold of acute hearing

complexity imparted to our problem when the psychological responses involved in the hearing function are admitted. A brief definition of the left- and the right-hand ordinates is appropriate, however. The scale on the left is indexed in sones, which is a linearized scale useful for securing values of the octave-band energy components in a form that permits their direct numerical summation to obtain a sone value representing the psychological reaction level of the total sound. The right-hand scale, calibrated in phons, is a distorted decibel scale whose distortion is made to correspond to the subjective loudness found by Fletcher to apply to a simple 1,000-cycle pure tone. Note that a sound of 10 sones is twice as loud as one of 5 sones and half as loud as one of 20 sones, as determined by a lengthy and elaborate series of judgment tests employing a large number of subjects.

The technique above described involves approximations that render it somewhat inexact under some conditions. For instance, it breaks down almost completely if the sound source is composed of a number of pure tones relatively closely spaced in the frequency spectrum. For sounds with broad band spectral characteristics, such as aircraft noises in general tend to be, the technique in fairly adequate.

I call your attention to the complexity of this, the only known means for handling this one part of the evaluation problem in noise control.

(*D*) *Mass Psychology*

Mass psychology can be taken to mean the influence of local public opinion or gossip on the tolerance and comfort of persons exposed to various noise levels. It is considered to be an item (or problem) separate and distinct from the psychological considerations of hearing discussed above. It is the fourth subdivision of my list and is even more difficult to discuss in the form of mathematical equations or logic than is the case for the other three.

The approximate decibel value of many typical sounds has been studied and is fairly well known. For instance, in Table 2 are listed a number of general situations with appropriate (though approximate) decibel values which may be considered to be representative. Although the numbers shown are *not* exact, they may be considered to be a guide.

The sort of sound level that a person tolerates without complaints or objections depends not only on the occupation in which he is engaged and the practice or experience he has had in the specific noise environment, but it also depends significantly on the presence of other persons experiencing the same sounds and the patience or quiescence of the others. Thus mass psychology may be of considerable importance. I shall hypothesize a single example to illustrate this.

Let us assume that under a given set of conditions in a specific community, noise from aircraft at an intensity of 85 db. has been experienced 10 or 15 times per day for short periods each time. We note from the table that this is intermediate in noise level between a noisy restaurant and a noisy factory. There have been no complaints and presumably the residents have noticed very little discomfort. Now let it be assumed that some change in the aircraft equipment serving the community causes the sound level to rise as high as 90 db. or the approximate equivalent of a noisy factory. Now it may happen that, experiencing 90 db. of noise disturbance, the residents begin to discuss their environmental disease among each other, first across backyard fences, then in church, then in offices, then in the editorials of the local newspapers, and finally in the borough hall.

If the noise level is changed back, by some means, to 85 db., the residents will not be content, and this is obviously the result of mass psychology. Indeed the sound will likely have to be pulled down to something like 70 db. (average speech at 3 ft) or even to 60 db. (quiet residential street) before all complaints disappear. Thus the effect of mass psychology is to cause a shift in the threshold of tolerability by a factor of 10 or 20 db., purely because the issue was publicly aired and it became stylish to gripe about it. People have become, in effect, acoustical hypochondriacs.

The principle of mass psychology has removed our problem from the realm of evaluation through application of the laws of physics and caused its treatment to become something of an art rather than a science. Thus we highlight just one more complicating and con-

fusing factor in the problem of evaluation and control of the aircraft noise problem.

(*E*) *Politics*

I am sure no one in the audience will experience any feeling of surprise when I list politics as an important factor in the aircraft noise problem. I have listed politics primarily in the interest of completeness of my table, but a solution to this hassle can hardly be expected to issue from research in a physics research laboratory and I will discuss the issue no further here.

(*F*) *Economics*

Economics is a basic factor underlying almost everything we do in life. The noise problem in aviation is no exception.

For example, the exhaust noise from a typical piston engine might be the main offense (presumably after one has secured a quiet propeller). Means of quieting the exhaust by a significant number of decibels are known; you simply install an adequate muffler system.

But economics is involved in two respects: (1) in that a suitably adequate muffler may involve such size and weight as to be impractical when economically evaluated against the associated loss of that precious commodity, pay load; or (2) in that a smaller muffler may serve acoustically except that it may increase the back pressure in the exhaust to such a degree that a significant loss of engine efficiency is incurred. To remedy the latter situation, one may utilize a larger engine, but this leaves one in trouble with pay load, as well as with fuel supply. The latter affects cruising range, and to regain cruising range one may increase the fuel capacity; but then pay load, already reduced by the heavier engine, again must pay with a fat slice of itself, and the new design goes out of business.

Perhaps propeller noise, usually more prominent than exhaust noise, is to be reduced. N.A.C.A. has found that significant improvement can be effected in certain cases by reducing blade tip speed, probably because certain aerodynamic noises are known to increase with up to the eighth power of the air velocity. One way to reduce tip speed is to rotate the propeller at a lower angular velocity. To secure the lower velocity, while permitting the enigne to turn at a speed where the power efficiency is high, may involve a gearbox and the weight of the gearbox may represent a substantial encroachment against pay load. In addition to lower r.p.m., the width of the propeller blades would probably have to be increased, and this incurs a penalty in weight. Probably the blades are made longer, too, and this may require a redesign of the landing gear in order that an acceptable clearance between propeller tips and the ground will be assured. As you can see, the problem is involved and difficult when you try to stay within the bounds of practical and acceptable economic restrictions.

Economic considerations also govern one's attempts in dealing with the noise situation by changing the ground operations. For instance, one might hope to zone the land in the vicinity of ground and low-altitude operations so completely that there would be no problem; but now we have incurred an increase in the difficulty of commuting from population centers to the airports for the passengers, and the cost of hauling freight to the point of take-off diminishes the virtues of air express for customers contemplating shipping by air. The cost of the land involved in zoning would be great indeed.

And so the problem of economics goes on and on. We could discuss it for days without repeating ourselves, but I am sure my point is made and I shall leave it at that.

(*G*) *Summary*

It will be apparent that I have not rendered even a single promising clue concerning means of solving the aircraft noise problem. This is because few clues of impressive merit are available at the present time, but it is also because my thesis was diagnosis rather than prognosis; in other words, I hope that I have demonstrated convincingly why the problem of silencing aircraft is so complex and difficult, if not actually improbable. As I close, however, I will review, by mention only, a summary of six basic fields from which help might ensue.

(1) Silencing at the source, while difficult and expensive, is a direction in which one may hope to secure some improvement.

(2) Isolation through zoning and through careful choice of operational procedures near airports may be helpful.

(3) Education of the people through experience and (possibly) propaganda may be an important factor.

(4) Modification of the ear is mentioned in the interest of completeness, though little can be expected to be accomplished here since the civilian population will be unwilling to habitually wear ear defenders (ear plugs).

(5) Politics is a factor of such importance it is worthy of mention, but I cannot offer promising leads at this time; you just have to live with it.

(6) Economics is a factor rather than a promise; it automatically follows the use of good engineering concepts in theory and in fact.

In closing, let me say that if I have succeeded in demonstrating to you the pattern of reasons why the problem of aircraft noise is so difficult, and will be difficult for some time to come, and if I have done this without creating an increase in the confusion concerning the problem, then I have accomplished the objective of this paper.

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Survival Worldwide

PAUL H. NESBITT*

Arctic, Desert, Tropic Information Center

SURVIVAL IS A UNIVERSAL TRAIT of human culture. It is composed of factors and elements that confront man in all of his relations and adjustments to the society and culture in which he lives. There is survival against disease, survival against business competitors, survival against communism, and even survival against taxes. Survival of this type is more appropriately labeled "Struggle for Existence"—biological struggle, economic struggle, and social struggle. In the nineteenth century Darwin wrote a series of books on the subject of the struggle for existence, and these have revolutionized our theories and conception of the biological and social worlds in which we live. It is not my purpose to cover survival of the Darwinian type.

The development and wide use to which the airplane has been put as a medium of transportation is responsible for the emergence of a new type of survival, which we call "emergency survival." Emergency survival is the ability to survive under conditions of deprivation and hardship. In this air age it is commonly brought about by forced landing of aircraft at sea or in sparsely populated and remote jungle, desert, and arctic areas. In the struggle for survival involving food, water, and shelter, a whole series of different problems is present in each geographical area—particularly in areas of climatic extremes.

The Air Force is spending vast sums of money and devoting much time and many man-hours on survival equipment and survival training. Survival equipment is developed by the Air Research and Development Command to meet the requirements of the Air Force. Indoctrination in the techniques and procedures involved in survival receives great emphasis throughout the Air Force. Why the Air Force is interested in survival training can be answered in terms of the dividends it will receive. First, the indoctrination in survival increases the morale of the pilots and air crews, a factor most important in preventing accidents during periods of both peace and war. Secondly, the Air Force does not regard its men as expendable, and indoctrination and training increases the chance of recovering highly trained technical personnel—personnel who have mastered their skills only after years of training.

Survival training through field exercises is engaged in by numerous Air Force commands including S.A.C., M.A.T.S., Alaskan Air Command, and others. Foremost in collecting and disseminating information pertaining to survival is the Arctic, Desert, Tropic Information Center of Maxwell Air Force Base, Ala. This organization is responsible for compiling information on Air Force operations in the nontemperate areas. Included in this responsibility is research on the subject of survival.

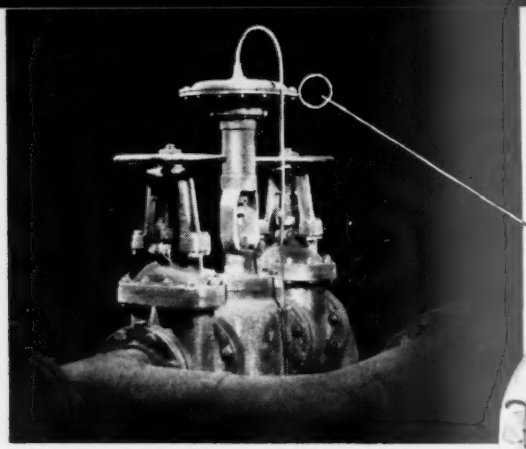
The A.D.T.I.C. is staffed by a group of specialists who are themselves survival experts and, through education and field experience, have a thorough knowledge of environmental conditions found in arctic, desert, and tropic areas. In the investigation of survival and problems involved, the A.D.T.I.C. has attacked the subject from two angles: (a) basic survival and (b) area survival. Basic survival concerns the basic procedures and techniques that should be used under all conditions of emergency survival. Regardless of the geographic areas involved, the elements of basic survival include food, shelter, water, and emergency equipment. Upon them are pyramided the special techniques and procedures most effective in each geographical area. Detailed information of this type is designated *area survival*, meaning basic survival plus specific information concerning food plants, shelter, people, methods of travel, water supplies, etc., for specific areas such as Afghanistan, Malaya Peninsula, Sahara Desert, Canadian Arctic, etc.

Recently, the A.D.T.I.C. completed for Headquarters U.S. Air Force, a manual, *AFM 64-5, Survival*. This manual outlines the basic factors of survival in arctic, desert, and tropic areas and will be available in published form early in 1953. In addition, current studies are being prepared on area survival particularly aimed at supplying detailed survival information on those areas traversed by Air Force flight routes. The subject of survival is also being approached through an analysis of survival experiences of Air Force and civilian personnel during World War II and the period following. An analysis of more than 1,000 tropical survival experiences has been made for the purpose of determining successful techniques and procedures, length of survival periods, and first-aid and medical needs. Information obtained from this analysis is available in A.D.T.I.C. publication, *999 Survived*. Currently, analyses are being made of 600 desert survival experiences, 700 arctic experiences, and some 2,000 water-survival experiences.

The results of these studies will be published during 1953. It is believed that this method of investigation will provide factual material highly beneficial and important to programs of indoctrination and training in survival.

Presented at the Air Safety Seminar of the Flight Safety Foundation, Inc., November 19–21, 1952, Bermuda.

* Chief.



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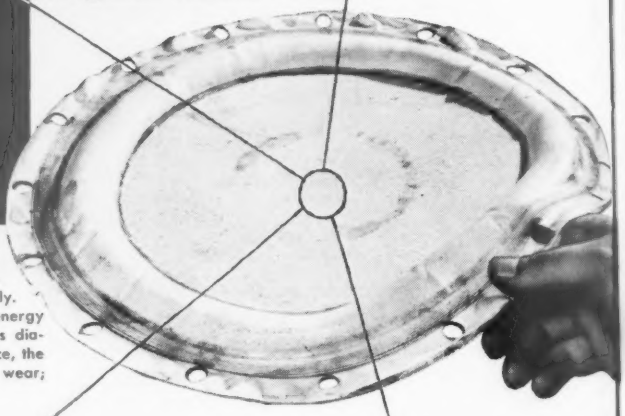

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Theoretical Pressure Recovery Through a Normal Shock in a Duct with Initial Boundary Layer

By

George McLafferty

United Aircraft Corporation

The theoretical pressure recovery through a normal shock in a duct having an initial boundary layer has been calculated on the basis of continuity and conservation of momentum. The results can be used to determine the maximum theoretical pressure recovery in supersonic compressors, supersonic wind-tunnel diffusers, supersonic ram-jet diffusers, and in any other case in which a wall boundary layer is present upstream of a normal shock. This calculation procedure has also been applied to diffusing passages having boundary-layer bleed systems to determine the maximum theoretical pressure recovery in both the main stream and the boundary-layer passage.

It is shown that the theoretical total pressure recovery through a normal shock in a duct is reduced by an amount proportional to the displacement thickness of the boundary layer approaching the shock for a wide range of approach boundary-layer profiles and approach Mach Number.

Quadruple Velocity Correlations and Pressure Fluctuations in Isotropic Turbulence

By

Mahinder S. Uberoi

The Johns Hopkins University

It is shown that the correlation of fluctuating static pressure (in an incompressible and homogeneous turbulence) with any fluctuating quantity in the flow field can be expressed in terms of the correlation of the same quantity with two or more components of the velocity.

The correlations of pressure with itself are investigated in detail for the case of isotropic turbulence. These correlations can be expressed in terms of correlations involving two velocity components at a point and two velocity components at another point. A postulated relation between the fourth-order and second-order correlations is investigated. This relation is satisfied, for example, if the joint probability density of the four components of velocity is Gaussian. The consequences of this relation are compared with the measurements of the fourth-order correlations.

The root mean square pressure and pressure gradients are computed from second-order correlation for a range of turbulence Reynolds Numbers. Since the pressure gradient is related to diffusion of marked particles from a source, the computed pressure gradient level is compared with that calculated from a set of diffusion measurements.

Forced Convection Heat Transfer from Horizontal Cylinders in a Rarefied Gas

By

F. M. Sauer and R. M. Drake, Jr.

University of California at Berkeley

An approximate analytical treatment of the energy equation is given which yields a specification for the average heat-transfer coefficients from horizontal circular cylinders to gases flowing at high Mach Numbers and low Reynolds Numbers. The results are given for continuum and slip-flow regions in comparison with available experimental data.

Inelastic Instability and Incremental Theories of Plasticity

By

E. T. Onat and D. C. Drucker

Brown University

A most troublesome paradox has existed for a number of years with respect to buckling in the plastic range. Theoretical considerations and all direct experimental evidence show conclusively that an incremental or flow type of mathematical theory of plasticity is valid. However, the results of plastic buckling tests are well correlated by a simple total or deformation theory and bear no resemblance to published predictions of incremental theory.

The suggestion was made that initial imperfections of shape or loading might well explain this most peculiar result. However, subsequent investigations by several authors seem to have given the impression that excessively large imperfections would be needed and that the answer would be overly sensitive to the magnitude of such imperfections.

It is the purpose of this paper to demonstrate that extremely small, and therefore unavoidable, imperfections of shape do account for the paradox in a simple manner. The buckling load is shown to be extremely insensitive to the amount of imperfection. The example chosen is a simplified version of the long rectangular plate hinged along one edge and free on the other under uniform compressive stress at the ends. This is the equivalent of the case of the cruciform column which has been so disturbing in the past because incremental theory applied to a perfect cruciform column did lead to an entirely incorrect result.

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Calculation Method for Three-Dimensional Rotationally Symmetrical Boundary Layers with Arbitrary Free-Stream Velocity and Arbitrary Wall Temperature Variation

By

Robert M. Drake, Jr.

University of California at Berkeley

A calculation method is presented enabling a rapid prediction of the distribution of the local skin-friction and heat-transfer coefficients to be made for rotationally symmetrical bodies having arbitrarily specified free-stream velocity distributions and surface temperature variations for constant property, incompressible, laminar boundary-layer flows. The

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method utilizes the Mangler transformation as a basis, thus enabling the results calculated by Hartree and Levy for the two-dimensional case to be used directly in the determination of boundary-layer quantities for the three-dimensional case.

Example results using the proposed method are presented in the form of the boundary-layer momentum and displacement thicknesses, the skin-friction coefficients, and the heat-transfer coefficients for a three-dimensional half-body with constant surface temperature. These results, utilizing the Hartree velocity profiles, are compared with similar results obtained by Scholkemeier utilizing the Pohlhausen P-4 velocity profiles. The skin-friction coefficient for stagnation-point flow as obtained by the approximate method is compared with the exact solution for this region given by Homann to show excellent agreement.

Thermal Distributions in Jeffery-Hamel Flows Between Nonparallel Plane Walls

By

Knox Millsaps and Karl Pohlhausen

Flight Research Laboratory, U.S.A.F.

The authors give the exact solution for the thermal distributions for the steady laminar flow of a viscous incompressible fluid between nonparallel plane walls held at a constant temperature. The velocity profiles are determined with the aid of Jacobian elliptic functions by using the Jeffery-Hamel solution of the hydrodynamic problem. It is shown that in this special case the energy equation giving the temperature profiles can be reduced to an ordinary linear differential equation with variable coefficients. After the introduction of dimensionless parameters, numerical solutions are given for diverging and converging channels with total openings of 10° for the possible combinations of three Reynolds Numbers and five Prandtl Numbers.

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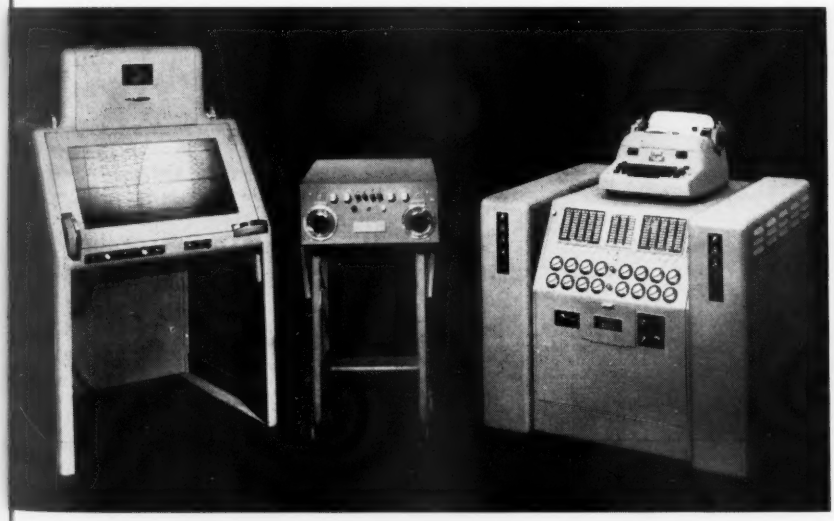

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General I.A.S. News

(*Continued from page 21*)

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The aircraft activities of the company at the present time consist primarily of the development and manufacture of precision instruments used in the flight test, fire control, and direction systems of various present-day aircraft and guided missiles. These instruments can be termed as components of systems of various types and are small, light, and "the ultimate in precision requirements and performance."

G. M. Giannini & Company is expanding its facilities and personnel to include in the future additional products applicable to both military and commercial aircraft. These new endeavors will include such items as recording systems for flight operations, indicating and recording devices for both reciprocating and jet engines, and laboratory apparatus pertaining to the aircraft field and its flight laboratories.

▶ **Paul Rosenberg Associates** has also added its name to the ever growing list of companies that are now Corporate Members of the Institute of the Aeronautical Sciences.

This firm of consulting physicists renders a professional service of consultation, research, and development in the industrial and military applications of physics and related sciences. Four classes of clients are now being served by P.R.A.:

(1) Industrial, manufacturing, and business firms to whom P.R.A. furnishes advice in planning programs of research and development; studies of trends in science and technology; and assistance in solving unusual manufacturing problems, in developing new manufacturing methods, and in designing and developing new products, machinery, and instrumentation.

(2) Banking institutions and investment firms who retain P.R.A. to study and evaluate the scientific and engineering merits of new devices, products, methods, and inventions.

(3) Engineering firms and others engaged in research and development to whom P.R.A. renders consultation on problems that require highly specialized knowledge and skill.

(4) The Government and Armed Services for whom P.R.A. does work of consultation, research, and development.

The current projects of Paul Rosenberg Associates are divided equally between the Government and private industry. The industrial clients are scattered throughout the United States.

The scientific interests of the company cover a wide variety of problems in electronics, ultrasonics, radar, television, optics, thermodynamics, kinetic theory of gases, precision mechanics, information theory, and operations analysis. The firm is active also in the fields of navigation, radar and other aids, radar mapping and charting, and flight training simulators.

P.R.A. maintains its own private laboratory, completely equipped for research and development work in many fields of applied physics. The firm, once located in New York's Woolworth Building, moved recently into expanded quarters in Mount Vernon, N.Y.

Fluid Mechanics Conference Planned

The Third Midwestern Conference on Fluid Mechanics is scheduled for March 23, 24, and 25 at the University of Minnesota, Minneapolis. The subject matter will cover all features of theoretical and applied fluid mechanics.

The General Chairman for this Conference is Dr. R. Hermann, of the University of Minnesota. Professor E. Silberman, of St. Anthony Falls Hydraulic Laboratory in Minneapolis, is serving as Program Chairman.

The Conference is sponsored by the American Physical Society's Fluid Dynamics Division, as well as by the local sections of the American Institute of Chemical Engineers, American Society of Civil Engineers, American Society of Heating and Ventilating Engineers, American Society of Mechanical Engineers, and Institute of the Aeronautical Sciences.

Necrology

Frank P. Callahan

Frank P. Callahan, who for a number of years served as General Electric Company's Corporate Member Representative to the Institute of the Aeronautical Sciences, died on December 21 at a Schenectady, N.Y., hospital. Death came as a result of a cerebral hemorrhage that he had suffered the previous day at his home.

Born in Hoosick Falls, N.Y., on March 26, 1905, Mr. Callahan attended St. Mary's Academy in Hoosick Falls and Troy Business College. In 1922, the year in which he was graduated from the latter, he joined G-E as a Student Clerk. In 1945, after serving in various capacities in the company, he was transferred to G-E's Corporate Affairs Division. Recently, he was transferred to Public Relations Services, continuing as Secretary of the Subscriptions Committee.

Mr. Callahan had been active for many years in Chamber of Commerce work, beginning with the Junior Chamber of Commerce and later transferring to the senior body. During that time, he served as National Councillor of the Schenectady Chamber of Commerce and as Secretary and Director of the Empire State Chamber of Commerce in Albany, N.Y. He had been Chairman of the National Industrial Conference Board's Special Council on Corporate Donations, Chairman of the Committee on Relations with Electrical Leagues of the National Electrical Manufacturers Association, and Chairman of the Product Scopes Committee of the N.E.M.A. He was also a member of the National Information Bureau and of the National Budget Committee. He had been prominent in district and national sports for over 20 years.

Sherman S. Graves

Sherman Stockton Graves, A.M.-I.A.S., General Manager of Cessna Aircraft Company's Helicopter Division, was killed in an aircraft accident on December 15 at the Richmond, Ind., Municipal Airport. The accident took place when the single-engined personal plane he was piloting collided in the air with a Lake Central Airlines' Douglas DC-3 while both were landing on intersecting runways at the Richmond airport. No injury to any occupant of the DC-3 was reported.

Born in Wichita, Kan., on November 6, 1913, Mr. Graves attended the local public schools and was graduated from Wichita High School in 1931. He took additional courses at night school where he studied welding, drafting, metallurgy, and aircraft materials and processes.

He entered the aircraft industry in 1936, when he first went to work for Cessna as an Aircraft Woodworker. He subsequently became a Mechanic, Layout Man, Experimental Mechanic, Engineering Department Inspector, Head of Inspection and Quantity Control, and Chief Inspector. He was responsible for setting up a physical and chemical laboratory and directed quantity standards for Cessna and the subcontractors. In April, 1952, he was named to head the then newly organized Helicopter Division.

Mr. Graves is survived by his wife, Doris, and his two children, Richard, aged 10, and Kathleen, aged 5, as well as by his father, three brothers, and a sister.

Major R. W. Schroeder

Major Rudolph W. (Shorty) Schroeder, an I.A.S. Member and Founder Member, died on last December 29 in Hines Veterans Hospital, Maywood, a suburb of Chicago, Ill. He was 66 years of age.

A pioneer in high-altitude flying and a test pilot, Major Schroeder learned to fly in 1910 and during World War I served as a Pilot in the U.S. Army Signal Corps' Aviation Section. In 1920, before high-altitude flight equipment had been developed, he flew an airplane to an altitude of 38,180 ft. That same year, he joined the Underwriters Laboratories and 5 years later became Superintendent of the Ford Air Transport, an air line operating between Detroit, Cleveland, and Chicago. While with Ford, he ran the first flight tests on the old "Tin Goose," the Ford Trimotor.

During the late 1920's, Major Schroeder served as Manager of Chicago's Curtiss Airport, which field he had designed and built. In 1933, he became Chief of the Air Line Inspection Service, Bureau of Air Commerce. Three years later, he was appointed Assistant Director of that Bureau. In 1937, he resigned to become a Vice-President of United Airlines Transport Corporation.

Among the various things for which Major Schroeder has been credited are (1) the organization of the first school of night flying, (2) designing and testing the first parachute flare and the first airplane lights for landing fields, and (3) conducting the first blind flying tests, the first controllable-pitch propeller tests, and the first supercharged engine tests. He was awarded the Distinguished Flying Cross in 1945 for altitude test flights that provided data "responsible in large measure for the success of the Army Air Force in World War II."

News of Members

▸ **Claude W. Brenner** (T.M.), Senior Engineer, Allied Research Associates, Inc. Formerly, Engineer, Aero-Elastic and Structures Research, Massachusetts Institute of Technology.

▸ **Oliver P. Echols** (F.), Chairman of the Board and President, Northrop Aircraft, Inc., was elected Chairman of the Board of Governors of the Aircraft Industries Association of America, Inc., for the second 6 months of 1953. General Echols is also a member of A.I.A.'s Executive Committee.

▸ **Harold E. Gray** (A.F.), who is in charge of the Latin American Division, Pan American World Airways, Inc., has been elected an Executive Vice-President of the corporation.

▸ **Otto E. Kirchner** (F.), Director of Operational Engineering, American Airlines, Inc., was elected to serve during 1953 as Vice-President for Air Transport of the S.A.E.

▸ **Cramer W. LaPierre** (M.), General Manager, Aircraft Gas Turbine Division, General Electric Company, Evendale, Ohio, has been elected a Vice-President of the company.

▸ **Dr. Angelo Miele** (M.) has joined the U.S. Government-sponsored supersonic research group at Polytechnic Institute of Brooklyn. He will be associated with the team in the group headed by Dr. Antonio Ferri (A.F.) which is concentrating on the basic problems relating to the design of testing equipment for models of aircraft constructed for supersonic velocities. Dr. Miele will also teach the undergraduate course, Applied Aerodynamics, and, beginning with the 1953–1954 academic year, will be in charge of courses on the graduate level dealing with flight mechanics of jet-powered aircraft and with the dynamic stability of airplanes. Dr. Miele was formerly Professor of Mechanics at Escuela de Aviacion Militar, Cordoba, Argentina.

▸ **Mundy I. Peale** (A.M.), President and General Manager, Republic Aviation Corporation, is serving during the first 6 months of 1953 as Chairman of the Board of Governors of the Aircraft Industries Association of America, Inc. Mr. Peale is also a member of A.I.A.'s Executive Committee.

▸ **Frank N. Piasecki** (F.), Chairman of the Board, Piasecki Helicopter Corporation, was selected by the U.S. Chamber of Commerce as one of America's Ten Outstanding Young Men of 1952. Mr. Piasecki was cited "for his leadership in pioneering the development of the helicopter industry." The banquet honoring these "Ten Outstanding Young Men" was held on January 17 in Cedar Rapids, Iowa.

▸ **Allen E. Puckett** (M.), Head, Missile Aerodynamics Department, Hughes Aircraft Company, has been appointed to the Committee on Guided Missiles, Research and Development Board, Department of Defense. Mr. Puckett had previously been Chairman of a panel of the Committee on Guided Missiles.

▸ **Arthur E. Raymond** (H.F.), Vice-President, Engineering, Douglas Aircraft Company, Inc., has been appointed a member of a new Defense Department committee on problems of defense against atomic attack.

▸ **Flight Lieutenant Alexander E. Sutherland,** R.C.A.F. (M.), is now on staff duty with the No. 2 Canadian Fighter Wing Headquarters in France in connection with the establishment of the No. 3 Canadian Fighter Wing. He was formerly Squadron Engineer-

ing Officer, 103 Rescue Unit, R.C.A.F. Station, Greenwood, Nova Scotia.

▸ **Clarence M. Young** (A.F.), who is in charge of the Pacific Division, Pan American World Airways, Inc., has been named an Executive Vice-President of the corporation.

Members on the Move

The purpose of this section is to provide information concerning the latest affiliations of I.A.S. members. All members are therefore urged to notify the News Editor of changes as soon as they occur.

Paul L. E. Alberti (M.), Design Engineer, Development Section, Republic Aviation Corporation. Formerly, Assistant Project Engineer, Chance Vought Aircraft Division, United Aircraft Corporation.

Rex Anger (A.M.), Air Carrier Maintenance Specialist (Instructor), Civil Aeronautics Administration, Aeronautical Center, Oklahoma City, Okla. Formerly, Aviation Safety Agent—Air Carrier Maintenance, C.A.A., ASDO San Juan, P.R.

Lieutenant Roger Gerard Archambault, U.S.N. (T.M.), Air Develoment Squadron Three, U.S. Naval Air Station, Atlantic City, N.J. Formerly, Field and Service Representative, Northrop Aircraft, Inc.

Bernard Arrow (M.), Research Engineer, Aero-Mechanics Division, Cornell Aeronautical Laboratory, Inc. Formerly, Vibration Engineer, Piasecki Helicopter Corporation.

Ralph L. Bayless (A.F.), Chief Development Engineer, San Diego Division, Consolidated Vultee Aircraft Corporation. Formerly, Chief Design Engineer, Convair.

Dr. Knox C. Black (M.), Business Manager, Polytechnic Research & Development Company. Formerly, Technical Advisor to Commander, Naval Air Development Center, Johnsville, Pa.

Allan F. Bonnalie (A.F.), Director of Training, Flight Operations Department, United Air Lines, Inc. Formerly, President and General Manager, U.A.L. Subsidiary, Lineas Aereas Mexicanas, S.A., Mexico.

Richard B. Brown (M.), Engineer, Consultant Section, Engineering Service Division, Engineering Department, E. I. du Pont de Nemours & Company, Inc. Formerly, Project Analytical Engineer, Chance Vought Aircraft Division, United Aircraft Corporation.

Charles Edward Chapel (M.), now Member of the Assembly from the Forty-Sixth Assembly District, California Legislature, Assembly Chambers, State Capitol, Sacramento, Calif.

Edmund W. Coates (M.), Senior Designer, Canadair Limited. Formerly, Senior Designer and Draughtsman, Helicopter Department, Aircraft Division, The Bristol Aeroplane Company, Ltd., England.

Nathaniel B. Cohen (T.M.), Aeronautical Research Scientist, Aerodynamics, Gas Dynamics Branch, Compressibility Research Division, Langley Aeronautical Laboratory, N.A.C.A. Formerly, U.S. Army Personnel, Aeronautical Engineer, Transportation Research and Development Station, Fort Eustis, Va.

PIASECKI PRESIDENT

Don R. Berlin became President of Piasecki Helicopter Corporation as of January 1, 1953, succeeding C. Hart Miller, who stays on as Executive Vice-President and General Manager. Mr. Berlin was formerly with McDonnell Aircraft Corporation, having joined them in 1947 as Vice-President of Engineering and Contracts. He was elected Executive Vice-President in 1949 and Vice-President and General Manager of McDonnell early in 1951.

Frank W. Davis (M.), Member of the Staff of R. C. Sebold, Vice-President—Engineering, Consolidated Vultee Aircraft Corporation. Formerly, Assistant Chief Engineer for Research and Development, San Diego Division, Convair.

Colonel Humberto Delgado, Portuguese Air Force (M.), Portuguese Representative to the North Atlantic Treaty Organization and Military and Air Attaché to the Portuguese Embassy in Washington, D.C. Formerly, Portuguese Representative, Council, International Civil Aviation Organization.

Millard F. Dowell (M.), Engineer Specialist and Consultant, Preliminary Thermodynamics Design, Evendale Plant, General Electric Company. Formerly, with Thermodynamics and Air Design Division, Aircraft Gas Turbine Division, General Electric, West Lynn, Mass.

Krafft A. Ehrick (M.), Development Engineer, Preliminary Design, Bell Aircraft Corporation. Formerly, Chief, Gasdynamics Section, Guided Missile Development Group, Redstone Arsenal, Huntsville, Ala.

Egan D. Foy (T.M.), Assistant Project Engineer, Chance Vought Aircraft Division, United Aircraft Corporation. Formerly, Air Technical Intelligence Specialist, Headquarters, U.S.A.F.

A. J. Grafman (T.M.), Engineering Supervisor, Frank Mayer Engineering Company. Formerly, in Tel-Aviv, Israel.

Heman J. Gurshaney (T.M.), Technical Officer, Technical Centre, Civil Aviation Department, Government of India, Safdarjung, New Delhi, India. Formerly, Aerodynamics Engineer, Canadair, Ltd.

Ian Malcolm Hamer (M.), Technical Director, Dowty Equipment of Canada Ltd. Formerly Chief Engineer, Dowty Equipment.

Paul L. Klevatt (T.M.), Vice-President, Company Engineer, and Part Owner, Commercial Pipe and Steel Company, Kansas City, Mo. Formerly, Engineer-Aerodynamicist, Sverdrup & Parcel, Inc.

Harold Lurie (A.F.), Assistant Professor of Applied Mechanics, California Institute of Technology. Formerly, Associate Engineer, The RAND Corporation.

Alan M. MacCallum (M.), Chief Engineer, M. J. Johnson Aircraft Engineering Company. Formerly, Chief Engineer, Allen D. Cardwell Manufacturing Company.

Harvey Wade MacFarland (A.M.), Buyer, Riverside (Calif.) Plant, Rohr Aircraft Corporation. Formerly, Field Maintenance Shop Officer, Strategic Air Command, March A.F.B., Calif.

Robert V. Meghreblian (M.), Senior Research Engineer, Reactor School Staff, Oak Ridge National Laboratory, operated by Union Carbide and Carbon Corporation's Carbide and Carbon Chemicals Company. Formerly, Research Engineer, Jet Propulsion Laboratory, California Institute of Technology.

Richard E. Moore (M.), Mechanical Engineer, Aeronautical Engineering Department, Hughes Aircraft Company. Formerly, Senior Project Engineer, Aeroproducts Division, General Motors Corporation.

Lieutenant M. V. Riccius, U.S.N.R. (T.M.), Aircraft Maintenance and Material Officer, Fleet Air Wing One, U.S. Naval Air Station, San Diego, Calif. Formerly, Senior Designer, Chance Vought Aircraft Division, United Aircraft Corporation.

Theodore Romans (M.), Senior Electro-Mechanical Engineer, The Glenn L. Martin Company. Formerly, Overseas Specialist-Aircraft Engineer, Government of Israel.

Yao Yuan Sze (T.M.), Senior Aeronautical Engineer, Pacific-Alaska Division, Pan American World Airways, Inc. Formerly, with Civil Air Transport, Formosa, China.

George B. Thorp (A.F.), now Engineer, Development and Design, Trans-Sonics, Inc.

J. E. Topping (T.M.), Flight Test Observer, The de Havilland Aircraft Company, Ltd., England. Formerly, Stress Engineer, de Havilland Aircraft of Canada, Ltd.

Edward N. Townsend (M.), Superintendent of Supply and Controls, Lockheed Aircraft Service-International, Inc. Formerly, Technical Manager—North America, British Overseas Airways Corporation.

Raymond A. Young (A.F.), Staff Engineer, Hiller Helicopters. Formerly, Head, Rotary Wing Design Section, Guided Missiles and Rotary Wing Branch, Research Division, Bureau of Aeronautics, Department of the Navy.

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American Helicopter Society News

The American Helicopter Society is most pleased to announce that the Port of New York Authority through its agent, Warren Goodman, has kindly offered to furnish free to any member of the A.H.S. a copy of its outstanding report entitled "Transportation By Helicopter 1955–1975." As most members know, this paper was published in November, 1952, and has been universally acclaimed throughout the industry as an outstanding contribution to the field of helicopter transportation. The Society strongly recommends that all members take advantage of this offer by writing to:

The Port of New York Authority
111 Eighth Avenue at 15th Street
New York 11, New York
Attn: Mr. Warren Goodman

Mr. Goodman advised that there may be a slight delay in the filling of requests received because the report is now going into its second printing. However, all requests will be filled. Each member is entitled to one copy only, so it is earnestly requested that members not ask for additional copies.

The Society is also most pleased to announce that Tom Ashley, Managing Editor of *Flight Magazine*, has presented complimentary copies, for distribution to all members, of the First Annual Helicopter Edition of *Flight Magazine*. Each member should have received his copy in the January mailing.

The Society wishes to extend its sincerest thanks to both Mr. Ashley and Mr. Goodman for making available to the membership these two fine publications.

Executive Board Notes

On January 9, the Executive Board held a meeting in which the following items of business were transacted:

(1) A general review of the Society's activities showed that technical papers have been mailed to the Society each month, that the membership has grown to over 700, and that the Forum Committee has made excellent progress in the formulation of the Ninth Annual Forum. The Forum will be held on May 14, 15, 16, and 17; headquarters will be the Mayflower Hotel. Pioneers' Dinner will be at the National Press Club on the fifteenth, and Honor's Night Banquet will be on May 16 at the Grand Ballroom of the Mayflower. Technical sessions will be held on the fourteenth and fifteenth, while the airshow, in conjunction with Armed Forces Day, will be held on the sixteenth and seventeenth. It is intended that static exhibits also be set up in the Mayflower. The technical papers will be available for sale at the Forum, and, as plans crystallize, more detailed announcements will be forthcoming.

(2) The Executive Board directed that each Regional Vice-President is to secure from his region a nomination for president, secretary, and treasurer, as well as two nominations for his successor. The seven regional nominations will then form the ballot that will be sent to all members for election of the 1953–1954 officers.

(3) As a result of the Constitution Committee's study, the old constitution was declared invalid by unanimous vote, and the proposed constitution submitted by the Committee was reviewed and revised. It was then accepted in its revised form by the Board, which directed that a copy of the new constitution with a ballot be submitted to all members for ratification by a majority of the votes cast.

(4) The Board then directed the Constitution Committee to prepare a new set of By-Laws in view of the fact that a search has shown that no copies of the original By-Laws exist.

New England Section

Over 200 persons attended the first seasonal meeting of the New England Section of the American Helicopter Society in Bridgeport, Conn., in December.

The meeting consisted of a plant tour of Sikorsky Aircraft Division of United Aircraft Corporation and a dinner and talk by Ralph Alex, Sikorsky Development Engineer, on "The Battlefront by Helicopter."

Ralph Alex

At Sikorsky, the members saw the production of the S-55 helicopter and its military counterparts (the HRS and H-19) and also the Marine HO5S. Alex's talk was illustrated by over 100 color slides, which he had taken on his recent trip to Korea.

Guests included Igor Sikorsky; Mr. and Mrs. G. Doman, of Doman Helicopters; H. M. Toomey, of C.A.A.; and M. L. Stevens, J. Emerson, I. Benson, and C. Kirchner, of Kaman Aircraft.

The committee, which organized the meeting under the guidance of Miller A. Wachs, Regional Vice-President, included M. L. Stevens, of Kaman; G. Doman, G. Montgomery, C. D. Adams, and B. A. Goodale, of Doman Helicopters; and J. Cherne and M. J. Theodore, of Sikorsky.

Southwestern Region

The fourth meeting of the Southwestern Region of A.H.S. was held in December at the Cattleman's Cafe in Fort Worth. Approximately 100 persons attended the dinner and heard Owen Q. Niehaus talk on "Auto-Pilots in Helicopters."

After service with the Army during World War II as a helicopter pilot and flight instructor, Niehaus joined Bell Aircraft Corporation as a test pilot and is now Senior Flight Test Engineer. The speaker outlined the early development of airplane autopilots, the problems of helicopter stabilization, the steps taken so far in solving the problem, and possible refinements to present helicopter autopilots.

The autopilot was developed for fixed-wing aircraft to reduce pilot fatigue. Early systems based on attitude stabilization were found to be lacking only for some airplane designs, particularly when the airplane possessed good stability characteristics. To offset this difficulty, rate signals were introduced. Although autopilots have been used successfully for many years in airplanes, installations in helicopters present problems not encountered in fixed-wing systems.

Stabilization of the helicopter at moderate forward speeds is comparable to airplane stabilization. In hovering, however, the problem is completely different. Since the ability to hover is the most valuable asset of the helicopter, an autopilot that is not effective through the entire speed range is of limited value. Deviations from a given flight path, which might be acceptable for an airplane, could be deleterious while rescuing persons from a restricted area.

As in fixed-wing aircraft, separate channels are used for roll, pitch, and yaw, utilizing both attitude and rate

signals. To provide adequate sensitivity, high-gain servo systems are used. The trend toward flight-path control rather than attitude stabilization has been adopted by Bell.

Since the motion of the entire helicopter is primarily dependent on the rotor, rotor position rather than fuselage position should be stabilized. Greater accuracy is required in helicopter autopilots because of the hovering problem. The pilot should be able to control the helicopter at all times even with the autopilot in operation. Special knobs and dials for autopilot adjustment or trim are to be avoided.

West Coast Report

Robert A. Wagner, West Coast Regional A.H.S. Vice-President, reported recently that activity in his region, while slow getting started, will soon be going at a fast rate. Reporting on a luncheon meeting held in December, Wagner said discussion revealed that many prospective members on the West Coast feel that the A.H.S. national headquarters in New York is somewhat remote. Wagner reported some difficulty in signing up new members and a feeling that the annual forum, if it is continued in Washington, can be attended by few West Coast members.

He also promised at least two papers from the West Coast region between March and June.

James Ricklefs, of Rick Helicopters, had agreed to speak at a February meeting on the West Coast along with Clarence Belinn of Los Angeles Airways.

CLAUDE O. WITZE
Publicity Chairman, A.H.S.

Corporate Member News

• **Aeroquip Corporation** . . . Recently introduced "Broach Fit" Bushings are said to offer advantages that eliminate many of the cost and production problems associated with the use of conventional-type bushings. The Aeroquip Bushing has a broached outer surface that creates "dozens of hard-cutting edges." The bushing is said to cut its way into cast metal, plastic, steel, and other metals without danger of collapse or cracking the parent metal. These bushings are made of hardened steel treated with a black oxide penetrate to prevent rust and corrosion. They are available in a wide range of standard sizes in both "headless type" and "head type"; special sizes can be furnished on request. . . . A licensing agreement has been completed with Super Oil Seals & Gaskets, of England, whereby this British firm will manufacture and sell Aeroquip hose, fittings, and flexible hose assemblies in Great Britain, Australia, New Zealand, and South Africa. The agreement includes the use of the Aeroquip name and trade-marks together with Aeroquip patents and know-how.

• **American Steel & Wire Company . . .** On January 1, 1953, Walter F. Munford became President of the company. Succeeding Mr. Munford in his earlier post as Vice-President of Operations was Van H. Leichliter. Mr. Leichliter's former position as Assistant Vice-President of Operations was filled by John A. Slenker.

• **Aviation Engineering Corporation** . . . Avien's electronic fuel gages, the company says, are now specified for more than 50 types of military aircraft.

• **Bendix Aviation Corporation** . . . According to a company release, a recently developed system, known as "Polar Path" Control, permits automatic course tracking in the Arctic where equipment using ordinary compass reference is useless. The "Polar Path" Control provides navigation and flight by automatic pilot without any reference to magnetic north, geographic north, or any radio signal. The system's directional reference is taken from a $1^1/_2$-lb. baseball-size gyroscope unit built so that the center of balance of the spinning mechanism is computed in millionths of an inch. The performance of this system is said not to vary over a temperature range of $-65°$ to $+158°$ F. It is further stated that this system is able to provide accurate course direction in several ways—e.g., lining up with an airport runway before take-off. This navigational system was developed especially for polar flight. This system is said to be useful on transoceanic flights in that it can provide "a new and highly accurate means of checking course computations determined by other navigational methods and is available at all times for electronic hook-up with associated equipment." . . . The fourth North Hollywood (Calif.) area plant of the Bendix Pacific Division is now in production. This new 60,000 sq.ft. plant is manufacturing electronic products.

• **Cessna Aircraft Company. . .** The U.S.-A.F. has awarded a contract to Cessna for the development of a twin-jet primary-training aircraft, designated the Cessna Model 318. The design proposal for the 318—the first jet trainer, designed as such, to be developed for the Air Force—provides for a lightweight all-metal single-wing aircraft. It will incorporate two-place side-by-side seating and will be powered by two 900-lb thrust Marbore-352 jet engines designed by Société Turbomeca, of France, and built in the U.S.A. by Continental Motors Corporation. According to the preliminary design, the 318 will have a wing span of 33 ft.; a length of 27 ft., 1 in.; and a height of 9 ft., 10 in. Its design gross weight will be approximately 5,600 lbs. Top speed of this trainer is expected to be more than 350 knots.

• **The Cleveland Pneumatic Tool Company . . .** A continuing and fully endowed scholarship has been established by the company at Case Institute of Technology in honor of the late E. W. (Pop) Cleveland, A.F.I.A.S., who was a Vice-President and Director at the time of his death last August 7 in an airplane accident. It will be known as the "E. W. 'Pop' Cleveland Memorial Scholarship" and is an addition to other funds recently provided by Cleveland Pneumatic for scholarships at Case.

• **Consolidated Vultee Aircraft Corporation . . .** Phase II flight testing of the YB-60 began on December 20 at Convair's Fort Worth Division. . . . J. V. Naish, who was formerly Vice-President for Sales and Contracts at Convair, has been elected Executive Vice-President of the company. J. G. Zevely has assumed Mr. Naish's former duties.

• **Eastern Air Lines, Inc. . . .** Robert Ramspeck, formerly Chairman of the U.S. Civil Service Commission, has become a Vice-President of Eastern. He is handling the details of Federal and State Governmental regulations involved in the operation of Eastern and reports directly to the company's president.

• **Fairchild Engine and Airplane Corporation . . .** A long-term lease has been signed for two recently completed buildings in the new industrial development at Roosevelt Field, L.I., N.Y. These two buildings are to be joined together by a smaller structure to provide approximately 250,000 sq.ft. of space. This new acquisition will apparently be used by the Fairchild Engine Division.

• **General Electric Company . . .** The Lockland Plant of G-E's Aircraft Gas Turbine Division has been renamed the Evendale Plant in order to agree with a redesignated geographical location. . . . In furthering the company's previously announced plan of decentralization, the general managers of eight operating divisions have been elected vice-presidents. Those elected were James M. Crawford; Francis E. Fairman; Cramer W. LaPierre, M.I.A.S.; Clarence H. Linder; Harold A. MacKinnon; Charles K. Rieger; Glenn B. Warren; and William C. Wichman. . . . Warde B. Stringham has been elected a Commercial Vice-President of the company. He succeeds Edwin E. Potter, G-E's Washington Vice-President, who retired after 43 years of service.

• **G. M. Giannini & Company, Inc. . . .** A recently announced precision potentiometer of $1^3/_4$ in. diameter is now available in single-section units with either a synchro-type or screw-type mounting. Both sleeve-bearing and ball-bearing models are manufactured with torque requirements of 0.5 oz.-in. for the ball-bearing unit. . . . A new accelerometer that utilizes a potentiometer resistance and is hermetically sealed in an inert gas was recently announced. Designated as the 24132, this instrument is obtainable in resistance ranges from 1,000 to 20,000 ohms and for any accelerometer measurement up to 30 *g* with special adaptations possible. Potentiometer element safely carries current up to 10 milliamp. The 24132 was designed for

TURBO COMPOUND CUTAWAY

This motor-driven cutaway of the Turbo Compound engine was put on public display for the first time recently by Wright Aeronautical Division of Curtiss-Wright Corporation. Designed for instruction and display uses, the cutaway shows, top center, one of the three exhaust-driven turbines and the fluid coupling and gear linkage which transmit turbine power to the crankshaft.

applications in computing, telemetering, and aircraft and missile control.

• **The B. F. Goodrich Company . . .** The development of a new lower-cost process for making "cold rubber" 50 times faster than current methods was recently announced. The process, still in the "pilot-plant" stage, produces high-quality cold rubber in 15 to 20 min. as compared with the 10 to 12 hours now required with present production methods. Rubber, by this method, is made in stainless steel pipes rather than in the presently used pressure vessels. This process is a result of 12 years research by company scientists and has been perfected under a research contract financed by the Synthetic Rubber Division of the Reconstruction Finance Corporation. . . . Available on request is a new catalog that describes five grades of air hose. Specifications are listed; materials and methods used in construction are covered along with recommended uses for the various types of air hose.

• **The Goodyear Tire and Rubber Company . . .** Five production divisions have been recently organized at Goodyear Aircraft Corporation. These are the Lighter-Than-Air Production Division, Parts Manufacturing Division, Airframes Division, Special Products Division, and Wheels, Brakes and Rocket Division.

• **Grumman Aircraft Engineering Corporation . . .** The Grumman S2F-1 anti-submarine aircraft made its first flight on last December 4. It is believed to be the first carrier aircraft that combines in one airplane the elements of submarine search and attack; thus, the new S2F-1 is able to perform by itself the jobs of both aircraft in the hunter-killer team. The S2F-1 is powered by two R-1820 engines, manufactured by Curtiss-Wright Corporation and Bridgeport-Lycoming, a division of Avco Corporation. Propellers on the ship are made by Hamilton Standard Division of United Aircraft Corporation.

• **Industrial Sound Control, Inc. . . .** The 180,000-sq.ft. American Dye plant of the Stevens Mills at Rockville, Conn., was recently purchased by Industrial Sound to permit the consolidation of operations of the company's five local plants. This new plant is expected to more than triple its output of sound-suppression materials.

• **Jack & Heintz, Inc. . . .** A new series of aircraft engine starters, said to be the first designed to meet specific requirements of the commercial air lines, was recently announced. Known as the JH6C Starter series, these starters are a result of the modification of the JH6 Starter by the addition of ten new features. Three JH6C Starter models are presently available: JH6CE for engines with cubic-inch displacement of 2,650–3,500 and with a $5^3/_4$-in. bolt circle; JH6F for engines with a 1,000–2,650 cubic-inch displacement and with a 5-in. bolt circle; and JH6CP for engines with a 2,650–4,500 cubic-inch displacement and with a special gear ratio for higher jaw speed, for use on engines having a starter jaw-to-engine crankshaft gear ratio of 3:1. The latter ratio on engines using the JH5CE and JH6CF models is 1:1. This new series does not render obsolete the JH6 Starters now in service. All JH6C parts are interchangeable with their counterparts in the JH6 series except the keyed-in-place sleeve bearings. . . . Walter J. Milde, a member of the law firm of Jones, Day, Cockley and Reavis, was recently appointed to the company's Board of Directors.

• **Kollsman Instrument Corporation . . .** The development of a line of extremely sensitive Pressure Monitors was recently announced. These instruments consist of a temperature-compensated diaphragm mechanism and an inductive pickoff. The pickoff, which is activated by the diaphragm, electrically signals the approach to a preset altitude and variations from that point within a specified range. These instruments are designed to reduce the friction factor to a minimum and are "ten times more sensitive to changes than earlier instruments of this type."

• **The Glenn L. Martin Company . . .** The Viking No. 9, one of a series of high-altitude rockets built by Martin for the Naval Research Laboratory, equalled the previous single-stage altitude mark of 135.6 miles on December 15 at White Sands Proving Ground, N.M. This rocket is completely redesigned and re-engineered. As a result, it is shorter by 6 ft. and of a slightly greater diameter and has completely new control, fuel, and electronics systems. The fins are smaller and triangular. The power plant, made by Reaction Motors, Inc., is the same type as previously used—i.e., one producing 20,000 lbs. thrust and using liquid oxygen and alcohol.

• **McDonnell Aircraft Corporation . . .** A new altitude environmental test chamber, said by the company to be the largest in the United States and probably the largest in the world, was recently completed at McDonnell. This new facility, designed to simulate altitudes up to 70,000 ft., has a temperature range of −100° to +165°F. Relative humidity can be controlled from 15 to 95 per cent at dew point temperatures above 35°F. In construction, this test chamber is actually composed of three chambers. The main one measures 20 by 11 by 9 ft. and can be merged with the 5-ft. long second chamber for testing larger objects. The third chamber is about the

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size of an average home-freezer unit. Several tests may be run in this new facility concurrently. . . . In a recent action of the Board of Directors seven executives of the corporation were elected to top management posts. Kendall Perkins, A.F.I.A.S., Vice-President—Engineering, was elected to the Board of Directors and to the Executive Committee. C. Warren Drake, Vice-President—Manufacturing and a member of the Board of Directors, also became a member of the Executive Committee, now composed of James S. McDonnell, Jr., F.I.A.S., President of the corporation and a 1953 I.A.S. Vice-President; Robert H. Charles, Vice-President—Contracts; and Messrs. Perkins and Drake. Elected Vice-Presidents of the corporation are: Garrett C. Covington, Airplane Chief Engineer; William A. Roth, Factory Manager; William R. Orthwein, Jr., Manager of Personnel and Public Relations and a Director of the corporation; and John F. Aldridge, Jr., Manager of Sales and Service. Robert H. Koenig, of the Fiscal Division, was elected Assistant Treasurer.

• **Minneapolis-Honeywell Regulator Company . . .** Glenn E. Seidel has been elected to the post of Vice-President in charge of Engineering in the company's Minneapolis plants. Mr. Seidel was formerly Director of the company's Ordnance Division and has been with Minneapolis-Honeywell's engineering organization since 1943.

• **North American Aviation, Inc. . . .** The U.S. Navy accepted the first production model of the FJ-2 Fury on December 11. This swept-wing fighter was designed especially for carrier operation and is powered by a General Electric J-47-GE-2 jet engine. Its wing span and length are both 37 ft. The highest point of the plane from the deck is 14 ft.

• **Pan American World Airways, Inc. . . .** Wilbur Morrison, Harold E. Gray, A.F.I.A.S., and Clarence M. Young, A.F.I.A.S., have been elected Executive Vice-Presidents of Pan American. Mr. Morrison is in charge of the Latin American Division; Mr. Gray, of the Atlantic Division; and Mr. Young, of the Pacific Division.

• **Seaboard & Western Airlines, Inc. . . .** The Seaboard & Western Airlines fellowships for studies at Columbia University's Graduate School of Business are being offered for the second consecutive year. These fellowships, valued at $2,000 each, are for the purpose of providing original research on a graduate level in the field of air transportation and are available to qualified men and women of this and other nations who are seeking masters' degrees or doctorates. Included in the curriculum of these fellowships are studies in the fields of economic geography, international business, marketing, and transportation—including air freight. . . . The ninth DC-4 freighter has been acquired by Seaboard and has been assigned to the transatlantic fleet of Airtraders.

• **Trans World Airlines, Inc. . . .** The DC-3 equipment on the line's medium-haul routes between Kansas City and the West Coast has been replaced by new Martin Skyliners. Similar equipment has been in service between T.W.A.'s eastern cities

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since January, 1952. This new fleet includes 12 Martin 2-O-2A's and 40 Martin 4-O-4's.

• **Vickers, Inc.** . . . Vickers Model AA-40510 is an 18 gal. per min. Pump Control Valve. It is for use wherever it is desirable to have automatic unloading of pump delivery at low pressure into the suction side when the oil temperature has reached a predetermined maximum. The design includes manual unloading of the pump. Maximum system pressure is limited by a built-in relief valve. A pressure-actuated electric switch is provided for use in a signal system to flag system pressure changes. The pump shutoff manual control also serves as a firewall shutoff device. A detailed description (A-5230) of this valve can be obtained from the Detroit office.

• **Western Gear Works** . . . A newly issued 35-page catalog on Pacific-Western Right-Angle speed reducers, spiral bevel and helical gear types, has been announced by Western Gear. Designated as *Bulletin 5203*, this catalog contains information to assist the customer in selecting the proper speed reducer for any job.

• **Westinghouse Electric Corporation** . . . An aircraft alternator voltage regulator using magnetic amplifiers has been developed by Westinghouse. This instrument, known as the AVR-22 Magamp regulator, contains no moving parts, electric tubes, glow tubes, or hot-wire devices. This regulator, which weighs 15 lbs., has a single screw adjustment. It is said to be interchangeable physically and electrically with the carbon-pile regulator over the full range of 400-cycle alternator ratings, from 15 to 90 kva. It is further said that it can be used with any constant-speed alternator that has already been built or is now under development at Westinghouse; it can also be used with either wye or delta connection of 120/208-volt alternators without changing the internal regulator circuit.

I.A.S. Sections

Boston Section

E. A. McBride, *Secretary*

The Boston Section held a joint meeting with the Institute of Radio Engineers on November 20, 1952. At 8:00 p.m., on the campus of Massachusetts Institute of Technology at Cambridge, Mass., Dr. T. P. Cheatham, Chairman of the Boston I.R.E., called the meeting to order. The program was started by a paper on "Automatic GCA System" by Robert C. Kelner of the M.I.T. Laboratory of Electronics.

Dr. Cheatham then presented the evening's speaker, William W. Wood, Chief Engineer of Link Aviation, Inc. Mr. Wood gave a most interesting talk entitled "The Modern Flight Simulator." He discussed the history of the Link trainer, which was a step toward modern flight simulators. Also, he explained how the simulators, which can be operated at only a fraction of the cost of the large aircraft, are proving their importance in pilot training today.

After a brief discussion period, Chairman Cheatham adjourned the meeting and expressed his thanks to Boston Section Chairman R. L. Bisplinghoff for I.A.S. participation. Approximately 100 members and guests attended the meeting.

Cleveland-Akron Section

R. E. Bolz, *Secretary-Treasurer*

The December 18 dinner meeting was held at the N.A.C.A. Lewis Flight Propulsion Laboratory and was attended by approximately 105 people. The program consisted of a social hour at 6:30 p.m., a buffet dinner at 7:15, and a general meeting at 8:00.

The main speaker was Otto E. Kirchner, who presented the Wright Brothers Lecture by William Littlewood. The lecture itself was attended by about 125 members and guests. A fine discussion of Mr. Littlewood's paper resulted.

Philadelphia Section

Emily Rogers Gibbs, *Secretary*

The January 7 meeting was held jointly with the Society of Automotive Engineers. Earl Stewart was Technical Chairman, and Harry S. Pack, Vice-President of Customer Relations, Piasecki Helicopter Corporation, gave an excellent talk accompanied by slides and movies on "Modern Military Helicopters."

The war in Korea has provided a proving ground for military helicopters. Out of their experience there, the Army, Navy, and Air Force have found new uses for helicopters, and these new uses, in turn, have resulted in improved designs. In order to work more closely with them in solving their problems, Mr. Pack practically commutes between Morton, Pa., and Korea.

On the day of this meeting, Mr. Pack had just completed his latest trip to Korea and gave a first-hand report on the present use of, problems faced by, and future development of the military helicopter to meet these problems. Mr. Pack's paper centered on the Piasecki H-21 Work Horse, largest production helicopter in the world. He emphasized the latest goals to be reached in greater speed, capacity, etc.

Over 200 were present. A number of new members was noted, and Frank N. Piasecki, Chairman of the Board, Piasecki Helicopter Corporation, was welcomed. Also welcomed back was Lt. Col. Alfred L. Wolf, one of our former chairmen, who has been abroad in Germany for a considerable time.

Seattle Section

Alvin J. Jarvis, *Secretary*

The January 6 meeting was held in the Health Sciences Auditorium of the University of Washington and featured a repeat of William Littlewood's paper for the Sixteenth Wright Brothers Lecture entitled, "Technical Trends in Air Transport."

The paper was presented by Otto E. Kirchner, Director of Operational Engineering, American Airlines, Inc. Mr. Kirchner was introduced by Wellwood E. Beall, I.A.S. President for 1952 and Senior Vice-President of Boeing Airplane Company.

The paper, illustrated by slides showing pictorially and by curves the growth of air transport from 1925 to the present, was well received by the audience of more than 200. Maynard L. Pennell, Senior Project Engineer of Boeing's jet transport development, was introduced to the audience and gave a commentary on the paper.

The lecture was preceded by a dinner given in honor of the speaker at the Seattle Yacht Club and was attended by the executives of Boeing Airplane Company and the officers of the Seattle Section.

Texas Section

Howard F. Marx, *Secretary*

"Aircraft Costs and the Designer's Responsibility" was the theme of the December 4 dinner meeting at the Lennox Hotel, Grand Prairie, Tex. Robert Lundberg, Design Cost Control Engineer, Chance Vought Aircraft Division of United Aircraft Corporation, was the principal speaker. A group of experts including Mr. Lundberg; Tom Harriman, Assistant Chief Engineer, Bell Aircraft Corporation; and John Williamson, Senior Design Engineer, Consolidated Vultee Aircraft Corporation, continued the discussion in panel form, following the formal presentation. Bert Brandon, program committeeman, acted as Moderator.

The trend toward higher costs of aircraft was illustrated by the contrast between the $52,000 unit cost of the F-51 airplane in 1941 and the $344,000 unit cost of the F-86 in 1951—an increase of more than 6 times! In discussing the problem of promoting cost consciousness among engineers, the experts agreed

Washington Section Meeting: *Shown at the speakers' table at the December 2 meeting of the Washington Section (from left to right) are: Dr. F. N. Frenkiel; Major Gen. L. E. Simon, U.S.A.; J. H. Sidebottom; and H. H. Porter.*

that adequate training courses are needed which should stress what processes are the easiest and cheapest to perform. Such processes should be used wherever possible in the design of new parts and components. Major items of aircraft costs were discussed, and a short question session was held before the meeting adjourned.

Washington Section

Paul J. Burr, *Secretary*

The December 2 meeting, devoted to the subject of "Guided Missiles," was held in the National Museum Auditorium. There were more than 130 guests and members present.

The meeting was opened by Chairman J. H. Sidebottom, who introduced Major Gen. Leslie E. Simon, U.S. Army, Chief, R. & D. Division, Army Ordnance, as Honorary Chairman for this meeting. General Simon aptly drew the frame of reference for the meeting. He also referred to the most pressing problem of missile reliability and pointed out that 25 per cent of the German A-4 missiles failed in take-off, while another 25 per cent failed during flight. General Simon then introduced the principal speaker of the evening, H. H. Porter, of The Johns Hopkins' Applied Physics Laboratory and Supervisor of the famous Bumblebee Project.

Mr. Porter limited his comments to surface-to-air missiles (anti-aircraft) and made several significant points, some of which follow:

(1) In pointing up the requirement for anti-aircraft guided missiles, he reminded that, at a distance of 5 miles, a fast plane will fly over 2 miles after an anti-aircraft shell leaves its gun and that few pilots are skillful enough to fly that distance accurately enough to be hit by a perfectly aimed shot.

(2) The primary characteristics needed in guided missiles are range, accuracy, and damage potential.

(3) Guided-missile development requires scientific progress in the fields of rocketry, jet propulsion, aerodynamics, structures, miniaturized electronics, servomechanisms, computers, and radar.

(4) To point up the philosophy of use of guidance systems, Mr. Porter made a division into systems where brains are built into the ground equipment, into the missile, or divided between the two. The command system represents the first one; the homing missile represents the brainy missile; and the beam rider represents the compromise.

(5) Assuming that enemy bombers fly at 600 knots, that missiles fly twice as fast, and that 5 min. be allowed for manning the missile-launching equipment, it was pointed out that to prevent an enemy plane from delivering an attack it must be detected 225 miles from the target.

(6) Analyses have shown that, when applying probability of kill per shot of guided missiles versus anti-aircraft shells, a stock of guided missiles will shoot down more enemy planes than a stock of shells of equivalent cost.

After his talk, Mr. Porter showed an interesting captured German film of V-2 firings.

Student Branches

Academy of Aeronautics

Frederick Berger
Corresponding Secretary

The December 11 meeting was the last one before the Christmas recess. Chairman Sherman Martin presided; 32 persons were present. General business was discussed and financial matters taken care of. The film, *Harnessed Lightning* (by courtesy of the Allison Division of General Motors Corporation), was well received by all members. The film explained the principles of turbojet and turboprop engines, along with views of production and flight-test operations. It concluded with pictures of Allison-powered airplanes in flight. The following pictures are scheduled to be shown at the first meeting of the new year: *The Navy Phantom* (courtesy of McDonnell Aircraft Corporation) and *Helicopters in the News* (courtesy of Sikorsky Aircraft).

Three more Branch meetings are scheduled before the end of the current academic term, when some of the present Branch officers will be graduated and a new officers' panel will take over. The above meetings will concern themselves primarily with the nomination and election of the new officers.

Agricultural and Mechanical College of Texas

Theodore C. Nark, Jr., *Secretary*

On November 11, the Texas A. & M. Student Branch convened for the first time in the new Aeronautical Engineering Building. The meeting was attended by 37 students and faculty.

Chairman Arthur Goldberg introduced E. E. Brush, Faculty Advisor, to the group. He in turn introduced the speaker for the evening, Fred E. Weick, who is a member of the Aeronautical Engineering Department faculty and director of the A. & M. Personal Aircraft Research Center. Mr. Weick was associated with N.A.C.A.'s Langley Aeronautical Laboratory for a number of years and is the author of numerous N.A.C.A. technical reports. He was also responsible for the design of the Ercoupe airplane and made this development the subject of his talk. Slides of the original W-1, the forerunner of the Ercoupe, were shown to illustrate the unique features of both aircraft.

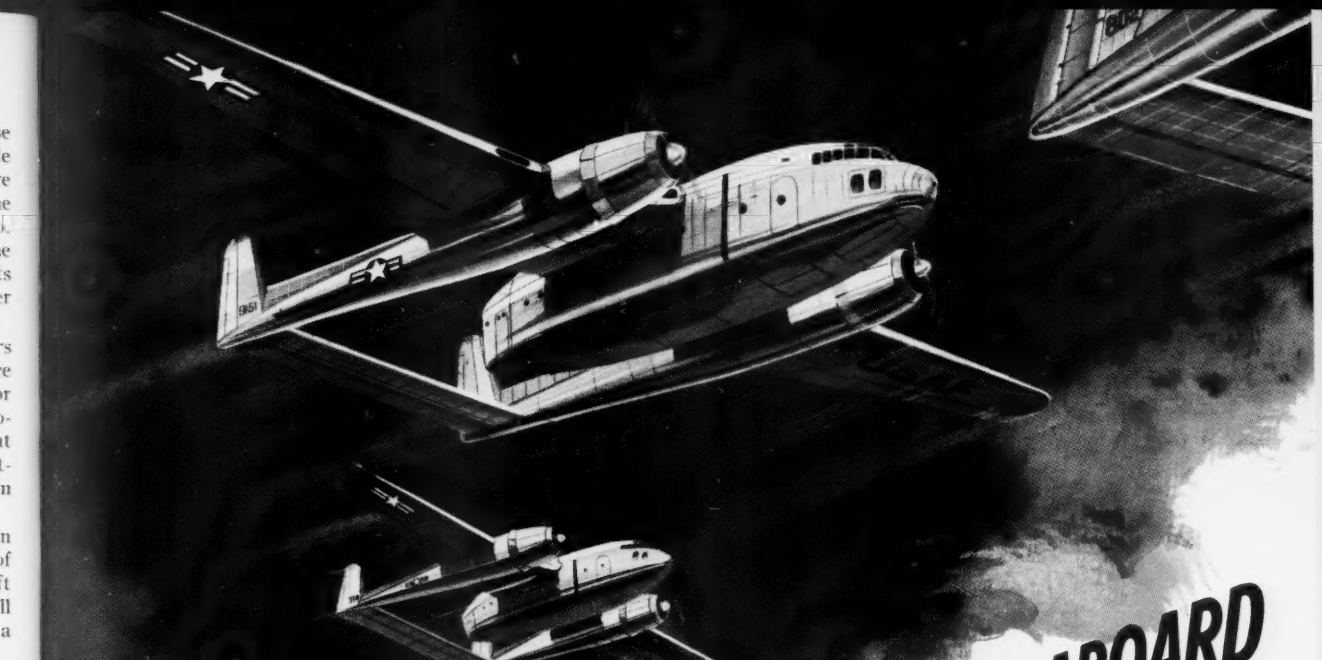
Refreshments and an informal discussion concluded the meeting.

Alabama Polytechnic Institute

William H. Morgan, *Secretary*

The Alabama Polytechnic Institute held its regular meeting on November 25. Chairman Terence Murphy was in charge of the meeting. We had 31 members present, with the addition of six new members.

The program was composed of a talk on helicopters by John Massey, a member of the Student Branch at Auburn. His talk covered the design of some of the various models of helicopters. He also explained their construction and



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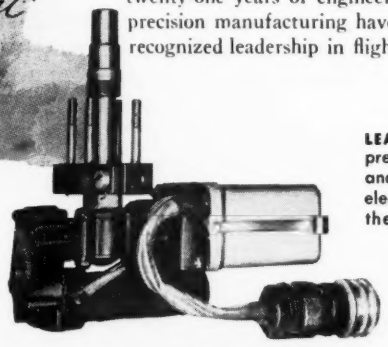

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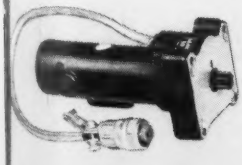
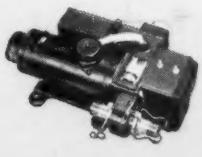
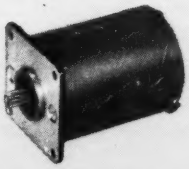


ROTARY ACTUATORS



POWER UNITS

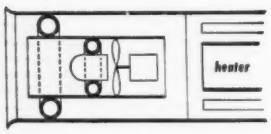


ELECTRIC MOTORS

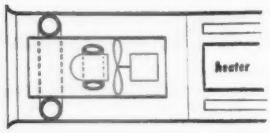
SCREW JACKS

janitrol heats new Fairchild C-119H

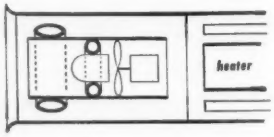
heater off
Inflatable air valves for both ram air and blower are fully closed.



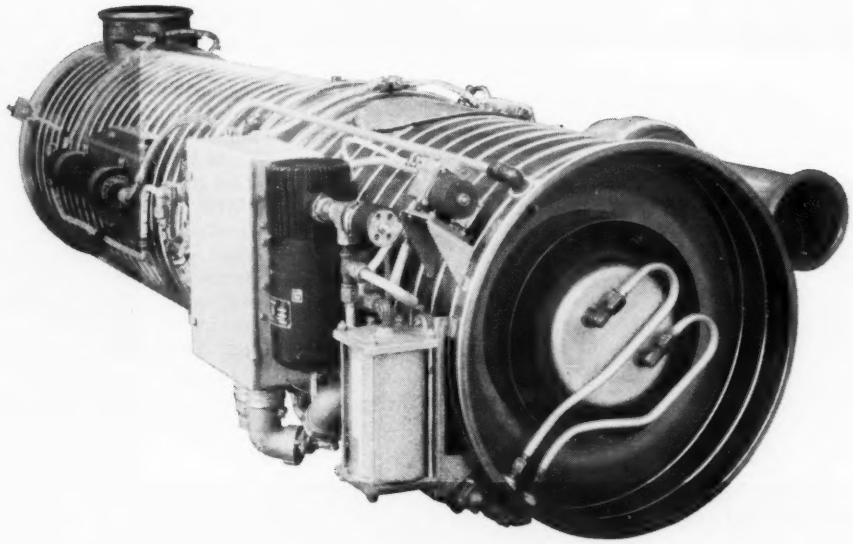
ground operation
Ram air intake automatically closed. Blower on and blower intake open.



in flight
Blower is automatically shut off. Blower intake closed. Ram air open.



package units fully automatic and interchangeable



Inflatable air valves . . . modulating type fuel control valves . . . automatic blower over-run after shut-down . . . simpler-than-ever push button operation . . . interchangeability of components or complete units—these headline the brand new Janitrol S-600 heater packages, five of which heat the new C-119H. The inflatable air valves shown at left represent the latest simplification of air intake control, and have proved themselves in the severest tests. Modulation of fuel supply is another important innovation: the system idles during periods of low heat demand, thereby avoiding the sudden temperature changes which would normally be experienced with on-off cycling.

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operation. Mr. Massey touched on some of the uses of helicopters in military and civilian aspects.

Plans are being made to attend the fire-power show at Eglin Air Force Base, Fla. This show is conducted by the Air Force to demonstrate the potential of the present Air Force.

New York University

John Schmitt, Jr., *Secretary*

On December 5, 25 members of the N.Y.U. Student Branch attended a technical smoker to hear a talk by Dr. Chi Teh Wang, Professor of Aeronautical Engineering at N.Y.U. Dr. Wang spoke on "Research at New York University" and gave a summary of the work in sandwich construction and prestressed skin which is being done at the Guggenheim School of Aeronautics at N.Y.U.

▶ A meeting was held on December 18 with Chairman William Zeltner presiding. Leonard Weiss, Senior Aeronautical Engineering Student at N.Y.U., gave a talk on convertiplanes. Mr. Weiss explained some of the limitations of the helicopter and told how the convertiplane would remedy these limitations. He concluded by discussing and illustrating some proposed convertiplane designs. Forty-two members were present to hear the talk.

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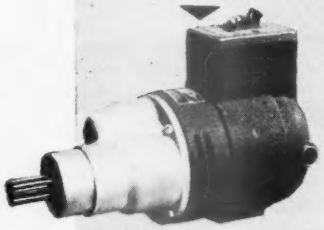
Many years of specialized experience in the design and manufacture of gear motors combined with the finest gear cutting equipment assure outstanding performance in Lamb Electric gear motors.

All Lamb Electric Motors are *specially engineered* for the product, which usually results in savings in space, weight and cost factor.

Geared head motor with reversing switch, adaptable to many heavy-duty, slow-speed applications.



Electrically governed, precision-built motor with accurate speed adjustment. Ideal for instrument use.

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The Pennsylvania State College

Frank A. Leader, *Secretary*

A regularly scheduled meeting of The Pennsylvania State College Student Branch was held December 10 on the Penn State campus with 60 members attending.

Our Chairman, Max Schuster, presided over the meeting and along with the regular business asked for a treasurer's report, which showed our chapter to be stronger financially than it has ever been. In view of this, the group voted to contribute $5.00 to the Student Scholarship Fund on campus. Max stated that, since final examinations would be drawing near in January, there would be no meeting that month; instead there will be two in February.

After a brief report by John Gaul, our Vice-Chairman and Engineering Student Council Representative, a motion picture entitled *Harnessed Lightning* was shown. It gave some basic jet principles and action shots of jet aircraft in operation.

Syracuse University

Charles E. Rogers, *Secretary*

Chairman Robert Mack called the October 14 meeting to order with 12 members present. The Membership Committee reported that arrangements had been made to contact the freshman engineers to inform them of our organization. Suggestions for obtaining up-to-date catalogs were made for guidance of the Library Committee. The Program Committee presented a film entitled *Guided Missiles* in which the various methods of employing guided missiles were explained.

The Robert Ostrander Memorial Plaque was shown to Robert Ostrander's parents who were pleased with it. Plans are being drawn up for the presentation of the plaque in the near future.

▶ On December 5, the meeting was opened by Vice-Chairman Fred Boenig in the absence of the Chairman. Ten members were present for the showing of the film, *The F-86A, Maneuverability and Capabilities*, which dealt with the Mach Number and *g* loading with respect to the operation of the aircraft in combat.

University of Colorado

Franz Nawrocki, *Secretary*

On December 16, a short meeting of the I.A.S. Student Branch at the University of Colorado was called to order by Chairman Cloman D. Bogart, with ten members present.

From two proofs, a picture of the group was selected to be placed in the university's yearbook, *The Coloradan*.

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As indicated by references at the right, you may have a choice of five different instruments (A) for quick and convenient standard rack mounting in the system at A_1, PLUS a choice of up to four of any of the three different type amplifiers (B) or any combination of these amplifiers

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SANBORN FOUR-CHANNEL OSCILLOGRAPH RECORDING SYSTEM (MODEL 67)

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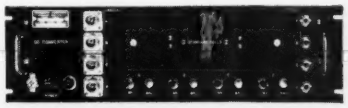
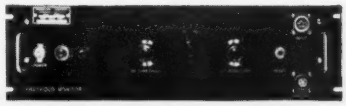
AC PREAMPLIFIER



DC CONVERTER—for low level DC recording such as thermocouple output.

TRIPLEXER—when coupled to a DC amplifier permits the recording of three events in one channel.



THRESHOLD MONITOR provides means for the control of voltage levels or rate of change.

B

DC (General Purpose) AMPLIFIER

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SERVO MONITOR AMPLIFIER—a phase discriminating AC amplifier used in servo design and testing.

As shown in the diagram, removing or interchanging any of the amplifiers or other instruments is simply a matter of sliding the unit in or out of the mounting rack where contact is made automatically by plug-in connectors. Screws at the four corners of the panel hold the instrument in place.

Other features of this system which add to Sanborn VERSATILITY are the choice of eight paper speeds—50, 25, 10, 5, 2.5, 1.0, 0.5 and 0.25 mm/sec, and the use of either 4-, 2-, or 1-channel recording paper.

And, of course there are these popular Sanborn advantages: a high torque movement (200,000 dyne cms per cm deflection), direct *inkless* recording in *true rectangular coordinates*, and provision for code and time markings.

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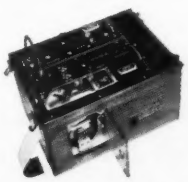


One channel Model 128/141 above and two-channel Model 60 at right both incorporate Sanborn recording advantages which include interchangeability of amplifiers and (with Model 60) preamplifiers.

A discussion of the annual banquet was followed by the appointment of a committee of four to investigate possible locations and dates for the event.

The secretary was instructed to obtain information about purchasing a subscription to *Aviation Week* for the organization.

The business meeting was adjourned, and a motion picture from North American Aviation, Inc., was presented.

University of Michigan

Hsueh-Ping Wu, *Secretary-Treasurer*

The third meeting of the fall semester was held on December 10 at the Michigan Union, University of Michigan. Chairman Warren File presided over the meeting. Program Chairman Kirke Comstock introduced our guest speaker, James O'Malley, of Bell Aircraft Corporation.

The topic of Mr. O'Malley's speech was the famous Bell X-5, an Air Force experimental plane with variable sweep wings. Mr. O'Malley talked on the basic structure and estimated performance of the plane with the aid of colorful slides. The climax of the talk came when he showed us a film, which showed certain stages of this plane while under construction and during the actual flight test.

Refreshments were served to approximately 44 student members and faculty members who attended the meeting.

The University of Texas

James M. Cooksey, *Secretary*

The University of Texas Student Branch met November 18. Chairman Felix W. Fenter presided; 36 members were present.

After a short business session, Chairman Fenter introduced Bill Schoolfield, Chief, Aerodynamics Section, Chance Vought Aircraft Division, United Aircraft Corporation, who addressed the meeting on "Progress in Carrier-Based Fighter Design Since 1942." Using as an example the Chance Vought "Corsair" of 1942, Mr. Schoolfield compared its performance to the performance that would be obtained if the same airplane were to have its piston engine replaced, first, by a jet engine with equal weight and, then, by a jet engine of equivalent horsepower. By means of this comparison, he brought out the many entirely new problems the engineer must face as flight speeds reach the high subsonic and transonic ranges.

▶ The Student Branch met December 16 with Chairman Felix W. Fenter presiding. Eighteen members were present. Following a short business session, Dr. M. J. Thompson, Chairman of the Aeronautical Engineering Department, announced award of the Douglas Aircraft Company scholarship to Felix W. Fenter.

The film, *Stability and Control*, produced by Shell Oil Company and the Civil Aeronautics Administration, was shown. The film illustrated the function of the various control surfaces in providing stability and making possible control of the airplane. After adjournment of the meeting, doughnuts and coffee were served.

The University of Tulsa

Robert Wolfe, *Secretary-Treasurer*

The Tulsa University Student Branch met on December 18 at the Petroleum Engineering Building. The meeting was called to order by Chairman E. H. Roberts with a total attendance of 12. Minutes of the previous meeting were read and approved.

It was decided that the January meeting would be postponed to avoid interference with final exams. Plans for the annual I.A.S. banquet were discussed and held over for later discussion. The possibility of viewing the Douglas plant here at Tulsa was discussed.

M. Akbar Ashraf gave a short, enlightening, and interesting talk on his home country, India, in which he reviewed the economic and educational status.

After the talk, two films on the AJ-1 Navy attack bomber and the Douglas C-124 Globemaster were shown.

The meeting was adjourned at 9:15 p.m.

Members Elected

The following applicants for membership or applicants for change of previous grade have been admitted since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Dunford, Ernest F., B.S. in Ae.E., Sr. Proj. Engr., East Coast Aeronautics, Inc.

Fero, Lester K., B.S. (Aero.), Ch. Struct. Engr., Bell Aircraft Corp.

Frank, Arthur S., B.S. in Ae.E., Jr. Asst. Ch. Engr., Grumman Aircraft Engineering Corp.

Hinckley, Herbert W., B.S.C.E., Asst. Ch. Engr., Consolidated Vultee Aircraft Corp. (Ft. Worth).

Nielsen, Jack N., Ph.D., Aero. Research Scientist P5-P6, N.A.C.A. (Moffett Field).

Ray, George D., B.S. in Ae.E., Ch. Prelim. Design Engr., Bell Aircraft Corp.

Stever, Horton G., Ph.D. in Physics, Assoc. Prof. of Aero. Engrg., Massachusetts Institute of Technology.

Elected to MEMBER Grade

Armstrong, Donald P., B.S., Asst. Ch. Engr., Bureau of Aero. Gen. Representative, Dept. of the Navy (Los Angeles).

Arnaud, Jean, École N Superieure de P'Aéronautique, Asst. Air Attaché, French Air Attaché, French Embassy.

Bendersky, Joseph, M.S.M.E., Tech. Engr., Aircraft Gas Turbine Div., General Electric Co. (Lynn).

Cagle, Ben, M.S.Ae.E., Sr. Proj. Engr., Southern California Cooperative Wind Tunnel (Pasadena).

Crane, Fred E., B.S. in M.E., Aero. Gas Turbine Power Plant Test Engr. GS-11. Aero. Engine Lab., Naval Air Experimental Station, N.A.M.C. (Philadelphia).

Danch, Gabriel C., B.S.Ae.E., Exec. Asst. to Dir. of Engrg., Ryan Aeronautical Co. (San Diego).

Eichman, Cuno, Ch. Draftsman, Pesco Products Div., Borg-Warner Corp.

Fraeys de Veubeke, B. M., A.E., Asst. Prof. of Aero. Engrg., University of Liége; Lecturer in Hydrodynamics and Aerodynamics, University of Louvain.

Gregson, Margaret, M.A., Stress Engr., Lockheed Aircraft Corp.

Griffith, John S., B.S., Thermodynamics Engr., Consolidated Vultee Aircraft Corp. (San Diego).

Haley, Dan J., B.S. in Ae.E., Staff Engr., Mech. Design Group, Boeing Airplane Co.

Hartley, J. B., Regional Field Engrg Mgr., Lord Manufacturing Co.

Hemond, Conrad J., Jr., M.S., Engr., Industrial Sound Control, Inc.

Herd, Robert G., B.S., Proj. Engr., General Electric Co.

Hess, Frederick W., B.S., LL.B.; D. Litt. (Hon.), Aero. Contracts Supvr., Hughes Aircraft Co.

Holmes, Howard, Vice-President & Gen. Mgr., Devel. & Sales, Simmonds Aerocessories, Inc.

Jones, Ralph W., B.S., Partner, Booz, Allen & Hamilton.

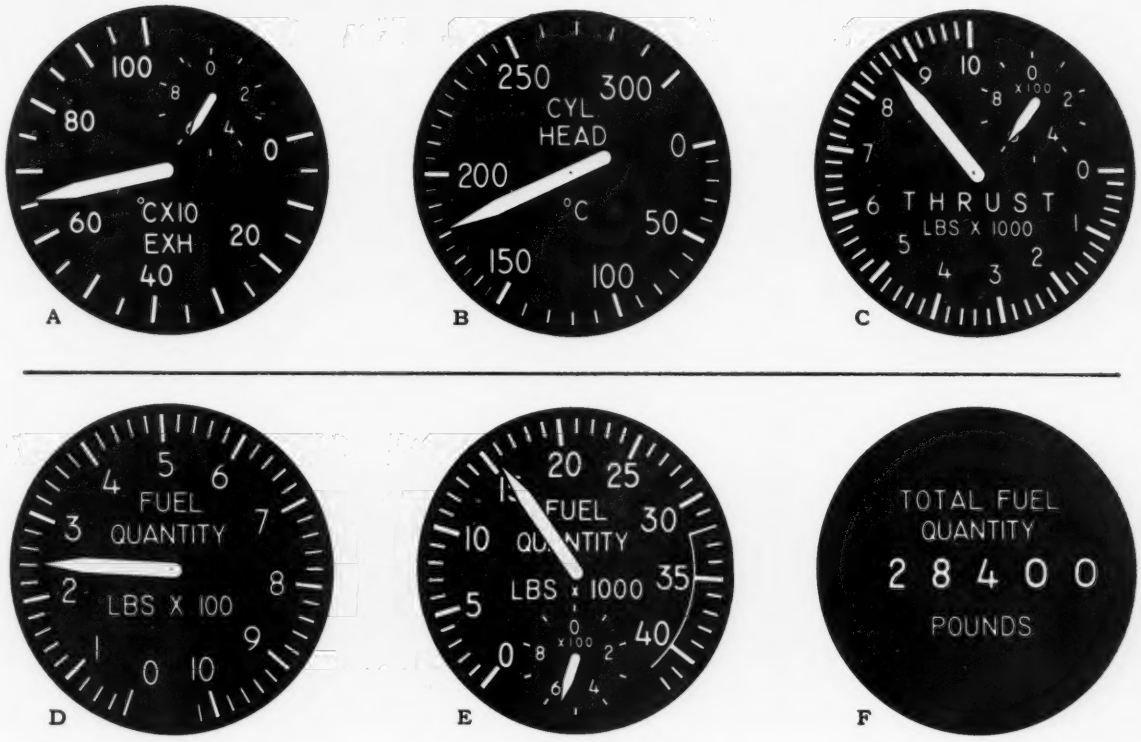
Knacke, Theodor W., M.S., Tech. Dir., 6511th Parachute Devel. Test Group, U.S.A.F. Flight Test Center, N.A.A.S. (El Centro).

McGhee, George D., B. of Ae.E., Designer "B," Douglas Aircraft Co., Inc. (El Segundo).

Morgan, Donald W., B.S.Ae.E., Proj. Engr., Sandberg-Serrel Corp.

Morrison, Richard B., Ph.D. in Ae.E., Ch. of Aircraft Propulsion Lab. & Asst. Prof. of Aero. Engrg., University of Michigan.

Norcross, Otis P., B.S., Supvr., Landing Gear Group, Lockheed Aircraft Corp. (Georgia).



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Palmer, Sidney C., B.S.M.E., Mgr., Transportation Dept., Westinghouse Electric Corp. (East Pittsburgh).

Petersen, Alfred H., Administrative Engr.; Cons. & Design Engr. to designers and manufacturers of commercial and aircraft equipment and parts, Harvey Machine Co., Inc.

Rand, Frank F., Jr., M.S.Ae.E., Section Supvr., Ford Scientific Lab., Ford Motor Co.

Raphael, Coleman, M.C.E., Principal Research Engr., Republic Aviation Corp.

Ryken, John M., M.S. in Engrg., Dynamics Engr., Bell Aircraft Corp.

Seibel, Charles M., M.S. Aero., Ch. Engr., Helicopter Div., Cessna Aircraft Co.

Smith, Earl A., Jr., M.S. in Ae.E., Aero. Power Plant Test Engr. GS-11, Aero. Engine Lab., Naval Air Material Center, Naval Air Experimental Station (Philadelphia).

Worden, Donald C., M.E., Asst. Proj. Engr., Consolidated Vultee Aircraft Corp. (San Diego).

Transferred to MEMBER Grade

Baer, Jerome C., B.S. in M.E., Aerodynamics Engr., Boeing Airplane Co. (Seattle).

Beilock, Milton, M.S. in Ae.E., Aero Engr., North American Aviation, Inc. (Downey).

Brame, Frank H., Sr. Design Engr., A. V. Roe Canada, Ltd.

Braunstein, Jules, B. of Ae.E., Material Review Engr., Republic Aviation Corp.

Carros, Robert J., B.Aero.E., Aero. Research Scientist, Ames Aeronautical Lab., N.A.C.A.

Clegern, William A., B.S.M.E., Ch. of Engrg., Flight Test, Consolidated Vultee Aircraft Corp. (Ft. Worth).

Deden, John T., B.S.Ae.E., Production Design Engr., Aero. Div., Minneapolis-Honeywell Regulator Co.

Fehrs, William, Jr., B.S. in Ae.E., Flight Test Engr., Grumman Aircraft Engineering Corp.

Freche, John C., B.S. in P.E., Aero. Research Scientist, Section C, Turbine Cooling Branch, Lewis Flight Propulsion Lab., N.A.C.A. (Cleveland).

Fuller, Richard G., B.S. in M.E., Aerodynamic Engr., Lockheed Aircraft Corp.

Harder, Keith C., Jr., Aero. Research Scientist-Section Head, Theoretical Aerodynamics Div., N.A.C.A., Langley A.F.B.

La Rosa, Salvatore, B. of Ae.E., Material Review Engr., Republic Aviation Corp. (Port Washington Div.).

Livingston, William Harold, M.Sc. in Ae.E., Lt. Comdr., U.S.N.; Test Pilot Training, Naval Air Test Center (Patuxent River).

Maslen, Stephen H., Ph.D., Applied Math., Aero. Research Scientist, N.A.C.A. (Cleveland).

McCoy, Allan W., B.S., Sr. Aero. Engr.-Group Leader, Fluid Dynamics Section, Aerodynamics Dept., Sverdrup & Parcel, Inc.

Nestingen, Irvin M., B. of Ae.E., Ch., Aerodynamics Div., Naval Ordnance Lab. (White Oak).

Noel, Robert G., B. of Ae.E., Stress Analyst—Research, Aerophysics Div., North American Aviation, Inc. (Downey).

Passman, Richard A., M.S.E.Ae.E., Proj. Aerodynamicist, Bell Aircraft Corp.

Powell, Frederic D., A.B., Proj. Engr. & Group Leader, Dynamics Dept., Bell Aircraft Corp.

Shaffer, Bernard W., Ph.D. in Applied Math., Asst. Prof. of Mech. Engrg., New York University.

Smith, Hamilton Allen, B.Ae.E., Contract Specifications Engr. "A," Boeing Airplane Co. (Seattle).

Stevens, Melvin E., B.S.Ae.E., Administrative Engr., Aerophysics Development Corp.

White, Richard P., Jr., M. of Engrg., Research Engr., Applied Mechanics Section, Cornell Aeronautical Lab., Inc.

Wick, Robert S., Ph.D., Sr. Research Engr., Jet Propulsion Lab., California Institute of Technology.

Elected to Associate Member Grade

Bergdahl, Edwin O., Jr., Dir., Contracts Mgr. & Sales Engr., Target Rock Corp.

Lewis, David G., Field Service Representative, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp. (Hagerstown).

McCoy, Betty J., Assoc. in Technology (M.E.), Service Engr., Chase Aircraft Co., Inc.

Meyer, William J., Service Analyst, North American Aviation, Inc. (Columbus).

Ring, Walter F., Engr. & Secy., Industrial Sound Control, Inc.; C. W. Lemmerman, Inc.

Transferred to Associate Member Grade

Nistal, Gerard E., B.S. & M.B.A., Advertising & Promotion Mgr., Govt. & Industrial Div., Philco Corp.

Walsh, James D., Major, U.S.A.F.; Ch., Organization Base & Maintenance, Equipment Section, Equipment Branch, Hq., Air Materiel Command, Wright-Patterson Air Force Base.

Elected to Technical Member Grade

Clarke, John T., Weights Estimator, Aircraft Div., A. V. Roe Canada, Ltd. (Malton).

Curtiss, Howard A., B.S.M.E. (Aero.), Power Plant Engr., Boeing Airplane Co. (Seattle).

Dunn, Robert T., B.S. (Engrg. Physics), Flight Test Engr., Power Plant Development & Test, North American Aviation, Inc.

Gehring, Richard W., B.S. in A.E., Stress Analyst "B," North American Aviation, Inc. (Columbus).

Hodge, Kenneth E., B.Aero.E., Engr., Guided Missile Aerodynamics, Grumman Aircraft Engineering Corp.

Keyes, Franklin M., B. of Ae.E., Aerodynamicist, Bell Aircraft Corp.

Kubik, Ralph E., B.S.M.E. (Aero.), Engineering Group Leader, Cessna Aircraft Co.

McAllister, William L.

McIntosh, Kenneth B., B. of Engrg., Production Design Engr., Lockheed Aircraft Corp. (Georgia).

Norheim, Torleif, B.S., Engineering Draftsman, Airframe Section, United Airlines, Inc.

Papanek, Andrew P., M.S.Aero.E., Proj. Engr., Jack & Heintz, Inc. (Cleveland).

Rigney, Richard N., Design Engr., Aerolab Development Co.

Smith, Nell, B.Ae.E., Proj. Analytical Engr., Chance Vought Aircraft Div., United Aircraft Corp. (Dallas).

Wallace, Charles W., Flight Engr. Supvr., Lockheed Aircraft Corp. (Marietta).

Transferred to Technical Member Grade

Alter, Oscar, Draftsman "B," North American Aviation, Inc. (Columbus).

Arterburn, Harold E., B.S. in Ae.E., Jr. Design Engr., C.V.A., United Aircraft Corp.

Barnett, Lane, B.S.M.E. (Aero.), Grad. Asst., Daniel Guggenheim School of Aeronautics, Georgia Institute of Technology.

Bell, Donald A., Mech. Designer, Turbo Products, Inc.

Bower, Edmund A., Jr. Engr.-Draftsman "A," Model Design Section, Aerodynamics Dept., Northrop Aircraft, Inc.

Burdick, Clinton D., A.E., Proj. Engr., Sperry Gyroscope Co., Div., The Sperry Corp.

Bush, Roger J., Designer-Draftsman North American Aviation, Inc. (Downey).

Dandy, Eugene F., B.S. in Ae.E., Mathematician "A," Performance Section, Aerodynamics Group, Douglas Aircraft Co., Inc. (Santa Monica).

Downer, Charles P., B.S. in Ae.E., Jr. Struct. Engr., Sikorsky Aircraft Div., United Aircraft Corp.

Dubas, Andrew, Methods Analyst, Republic Aviation Corp.

Eck, Arthur, Flight Test Analyst, Northrop Aeronautical Institute at N.A.M.-T.C. (Pt. Mugu).

Ekstrand, Jerome D., B.Aero.E., Jr. Engr.—Hydrodynamic Research & Design, Consolidated Vultee Aircraft Corp. (San Diego).

Foat, E. Ace, Engrg. Draftsman, North American Aviation, Inc. (Los Angeles).

Fontana, Saverio J., Designer, Grumman Aircraft Engineering Corp.

Foss, Willard E., Jr., B.S. in Ae.E., Aero. Research Scientist, Propulsion Group, N.A.C.A., Langley Aeronautical Lab.

Gartrell, Don Alan, Jr. Engr.-Draftsman "B," Lockheed Aircraft Corp. (Burbank).

Goodman, Verlin E., Draftsman "A," North American Aviation, Inc. (Downey).

Hackman, Lloyd E., B.S., 2nd Lt., U.S.A.F.; Proj. Engr., A.F.F.T.C., Edwards A.F.B.

Hagberg, Calvin A., B.S.M.E. (Aero.), Engineering Draftsman, Cessna Aircraft Co.

Hamm, George H., B.S. in Ae.E., Flight Test Engr., Piasecki Helicopter Corp.

Hannaford, John M., Student Draftsman, Pratt & Whitney Aircraft Div., United Aircraft Corp.

Harris, William A., B. of Ae.E., Lt., U.S.A.F.; Assigned as Armament Systems Officer, General Electric Co.

Hendershot, Kenneth C., B.S. in Ae.E., Asst. in Research, Willow Run Research Center, University of Michigan.

Higaki, Kazunobu R., B.S., Engrg. Draftsman "B," North American Aviation, Inc. (Los Angeles).

Hoshizaki, Hiroshi, B.S., Grad. Student, University of California.

Kahre, Kenneth J., A.A., Engineering Draftsman & Designer, Gray & Huleguard, Inc.

Kingsland, Richard B., B.S. in Ae.E., Mathematician, Douglas Aircraft Co., Inc. (Long Beach).

Kossar, Jerome M., B. of Ae.E., Lt., U.S.A.F.; Proj. Officer, A.D.C., Wright-Patterson A.F.B.

Kruger, Nicholas, Jr. Stress Engr., Sikorsky Aircraft Div., United Aircraft Corp.

McElheny, Ralph A., B.S. (Air Transportation), Ticket Agent, United Air Lines.

Meissner, Claus J., B.S., Jr. Engr., Struct. Group, Consolidated Vultee Aircraft Corp. (San Diego).

Mitchell, Keith, B.S. in Ae.E., Grad. Student, Dept. of Aero. Engrg., University of Notre Dame.

Pollard, Willard A., III, M.S. in Ae.E., Lt. & Naval Aviator, U.S.N.

Reed, Albert O., Line Mechanic, Aerodex, Inc.

Reed, Robert H., Jr. Engr., Northrop Aircraft, Inc.

Rifkin, Morton S., Ch. Draftsman, Tycoon Tackle, Inc.

Rivera, Armando.

Rizer, Robert J., B.S. in Ae.E., Engrg. Asst. "A," Aerodynamics Group, Douglas Aircraft Co., Inc. (Santa Monica).

Rogers, Earl, Lab. Technician, AiResearch Manufacturing Co. Div., The Garrett Corp.

Rosky, John K., A.A., Weight Analyst "B," North American Aviation, Inc. (Downey).

Schwanhausser, Robert R., S.B. in Ae.E., Lt., U.S.A.F.; Proj. Officer, 6580 Missile Test Group, Holloman A.F.B.

Schwartz, Melvin B., B.S., Aerodynamicist "C," North American Aviation, Inc. (Columbus).

Sutor, Thomas J., B. of Ae.E., Aero. Engr., Analysis Section, Research Dept., United Aircraft Corp. (East Hartford).

Thrash, William L., Template Maker, North American Aviation, Inc. (Columbus).

Van Tassell, Warren H., Research Technician, Aircraft Engine Div., Ford Motor Co.

Weller, Spencer A., B.S.M.E. (Aero.), Draftsman "A," North American Aviation, Inc. (Columbus).

Williams, John D., Jr.

Woodard, Kenneth S., B.S., Jr. Layout Draftsman, Sikorsky Aircraft Div., U.A.C.

Yeager, Maurice R., B.S., Vibration Engr., Kellett Aircraft Corp.

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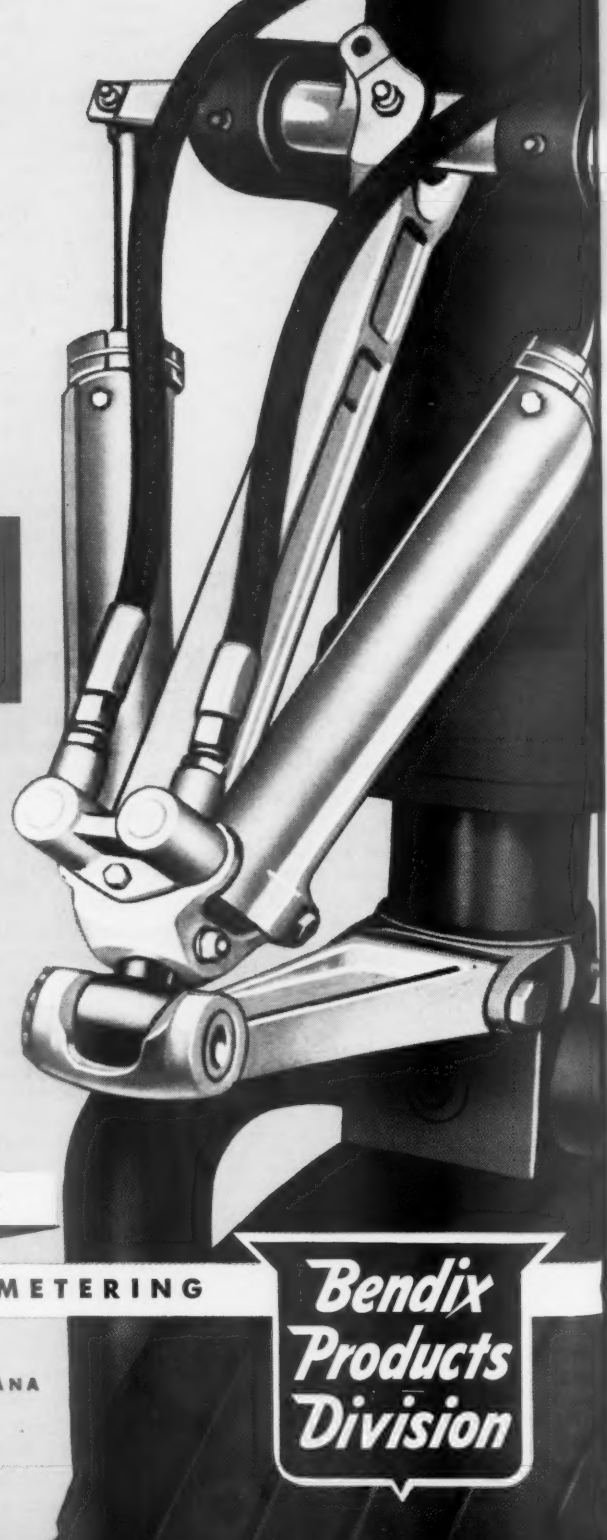

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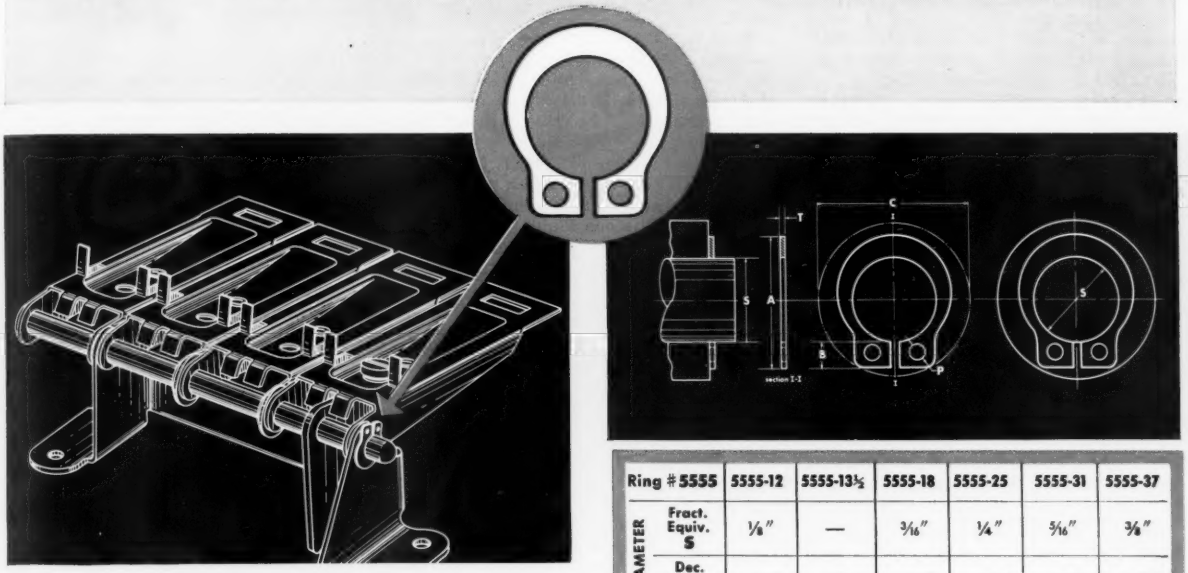

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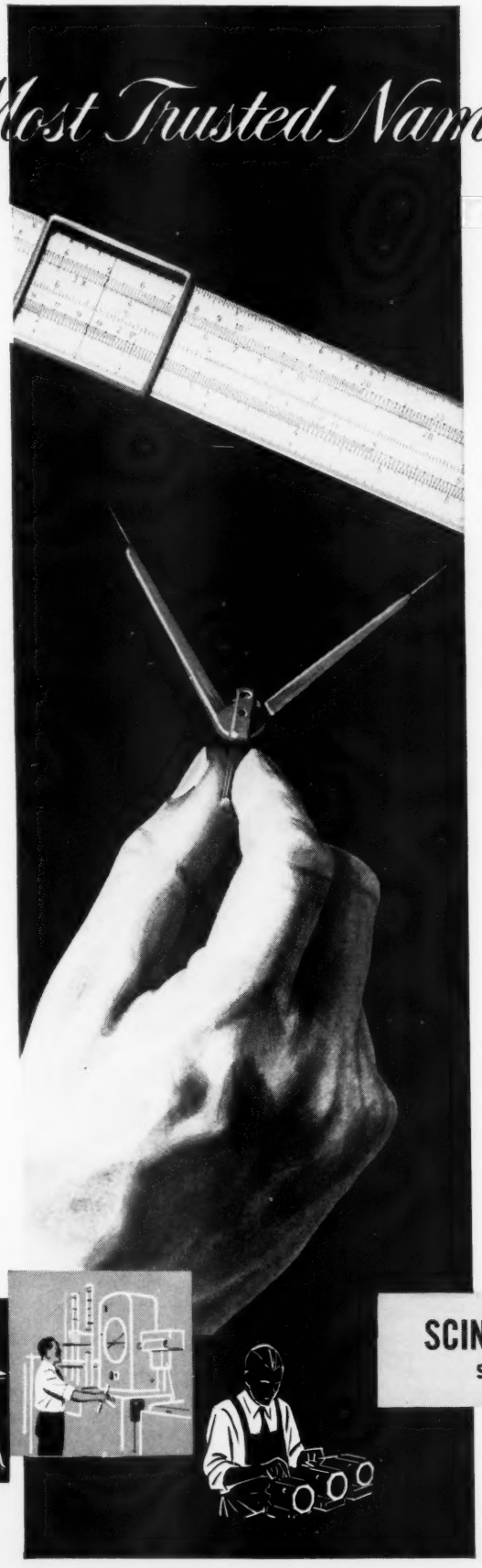

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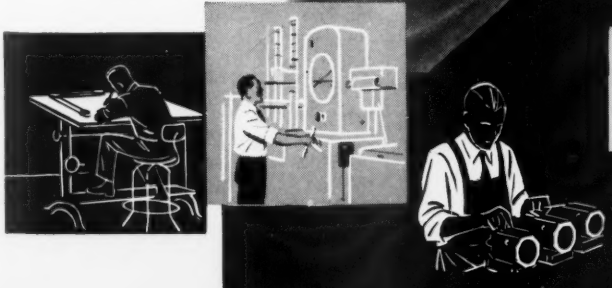

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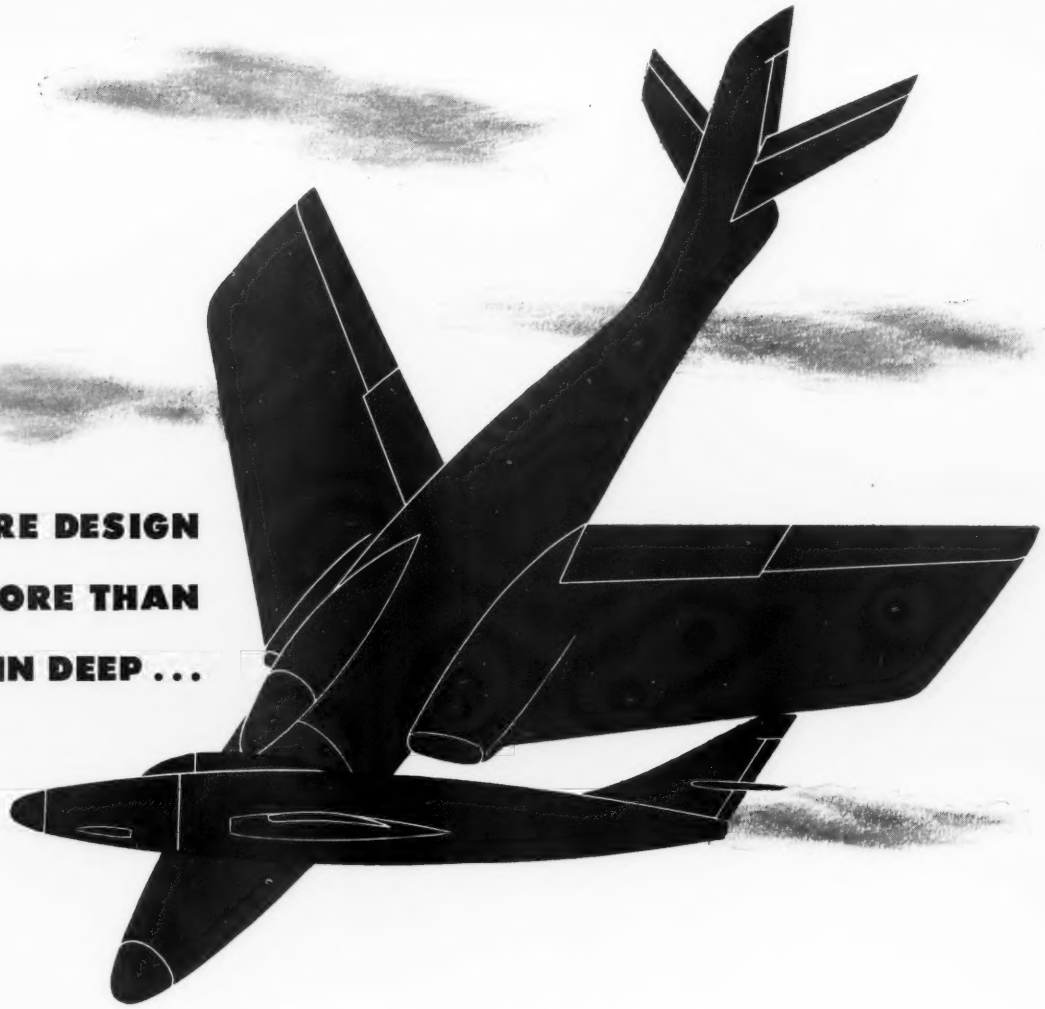

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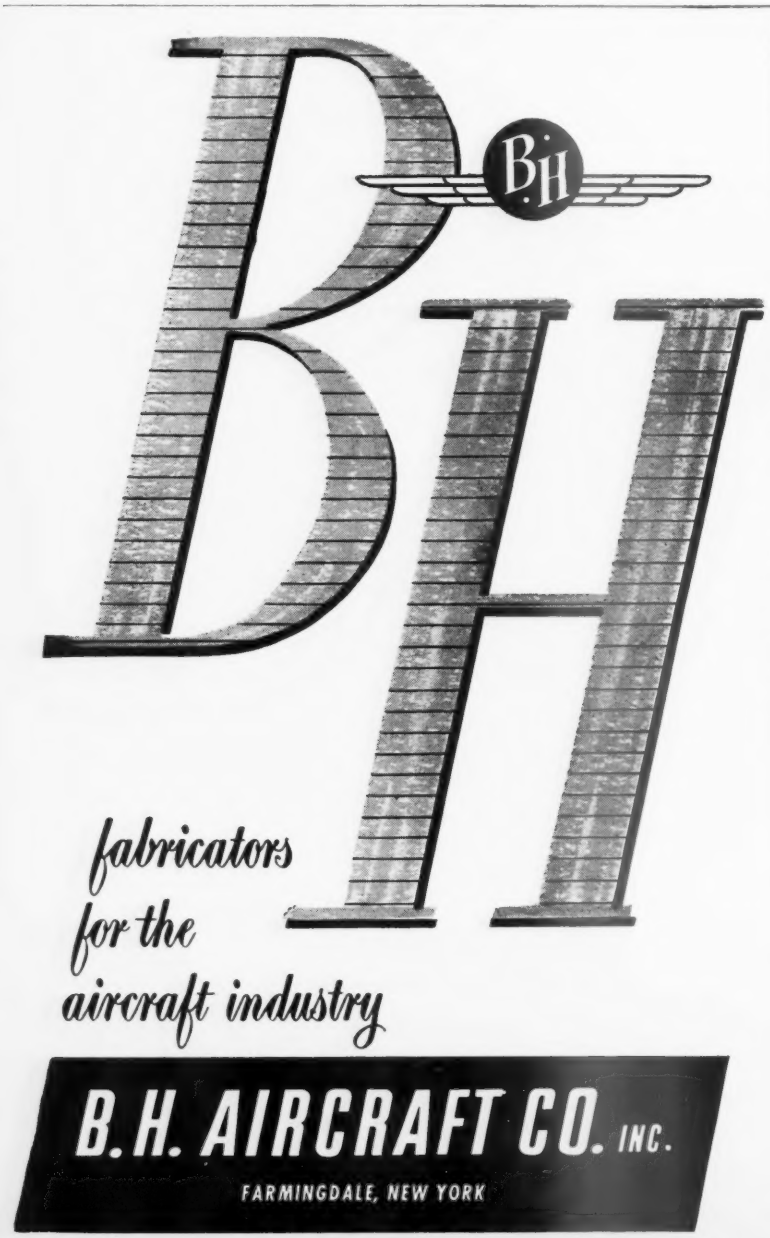

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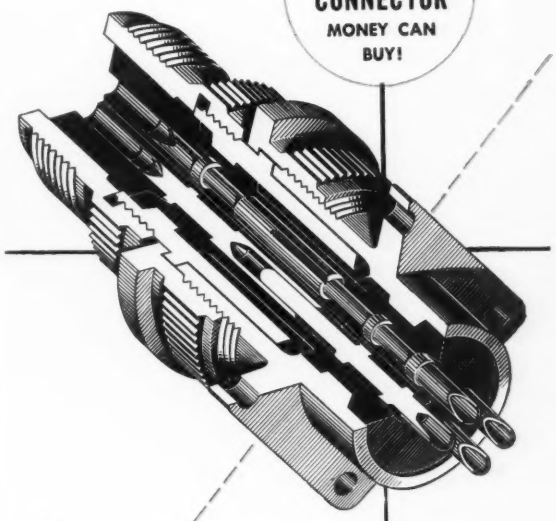

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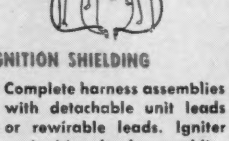

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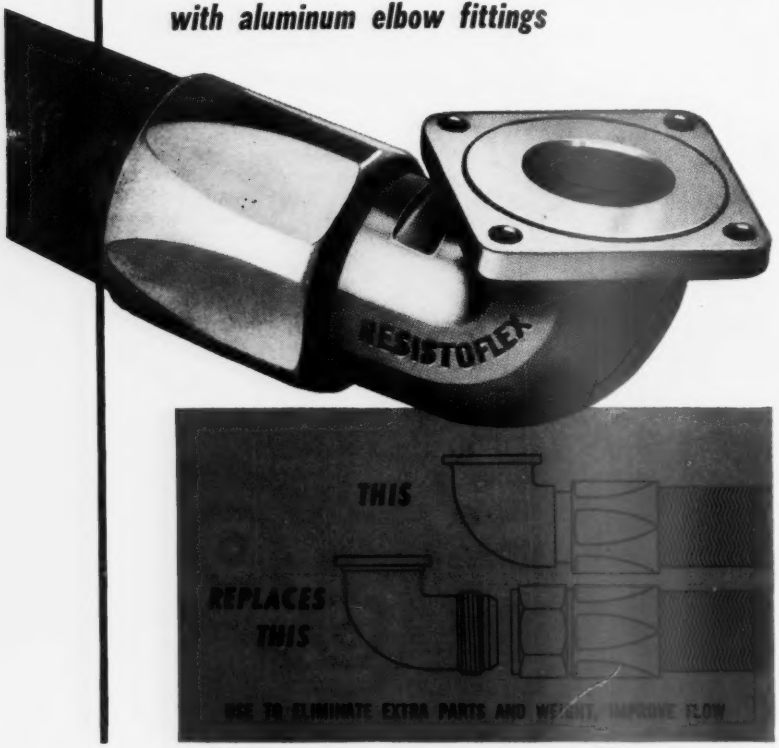

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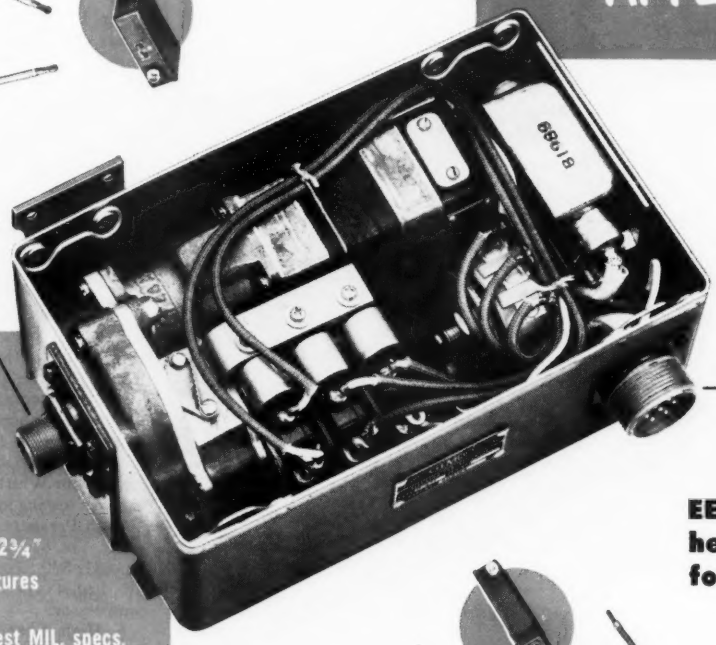

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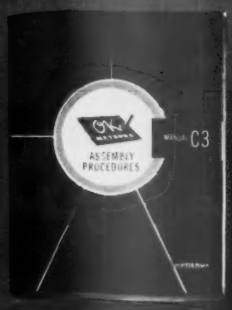

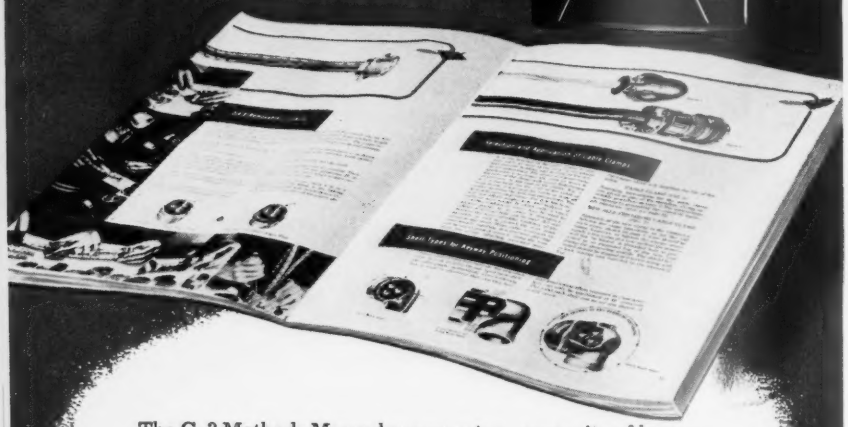

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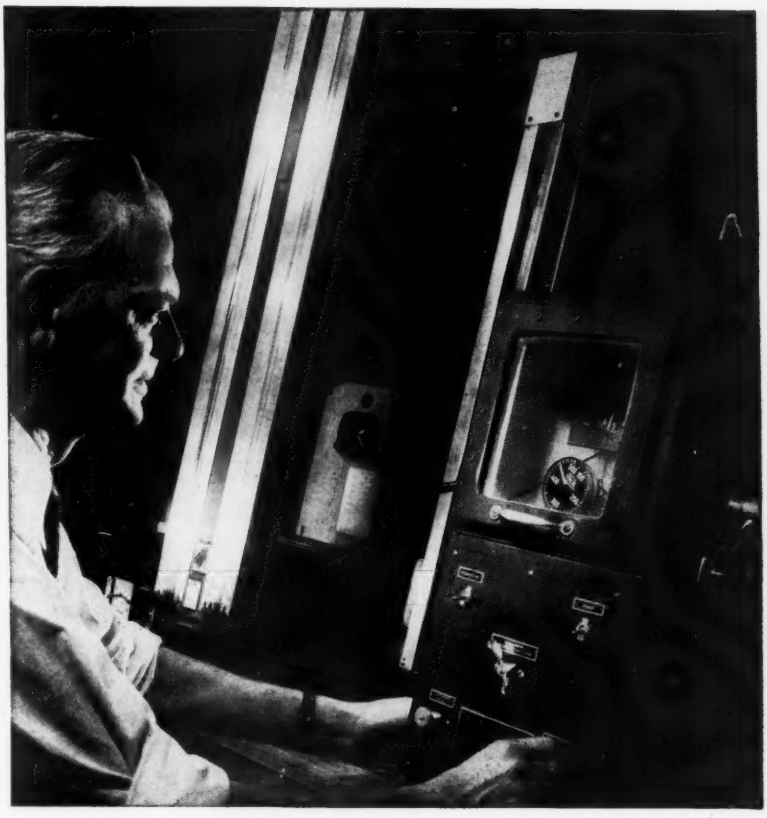

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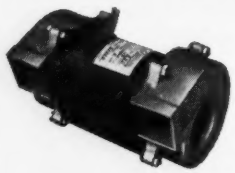

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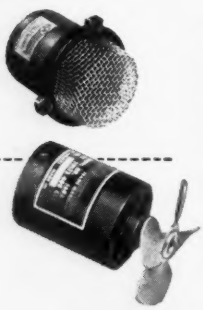

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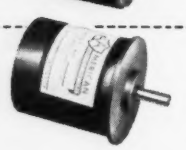

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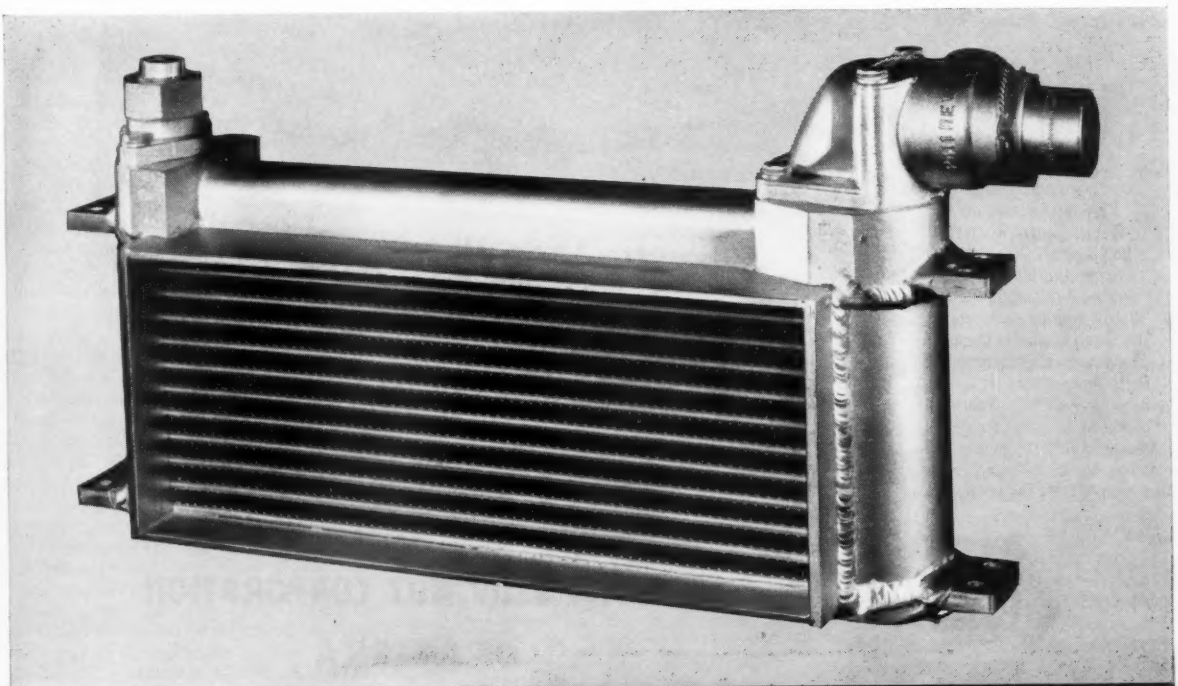

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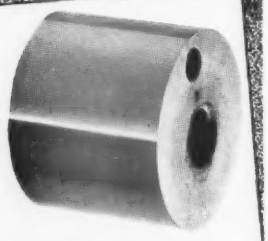

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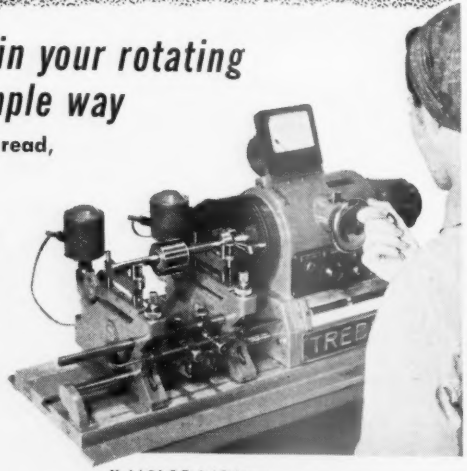

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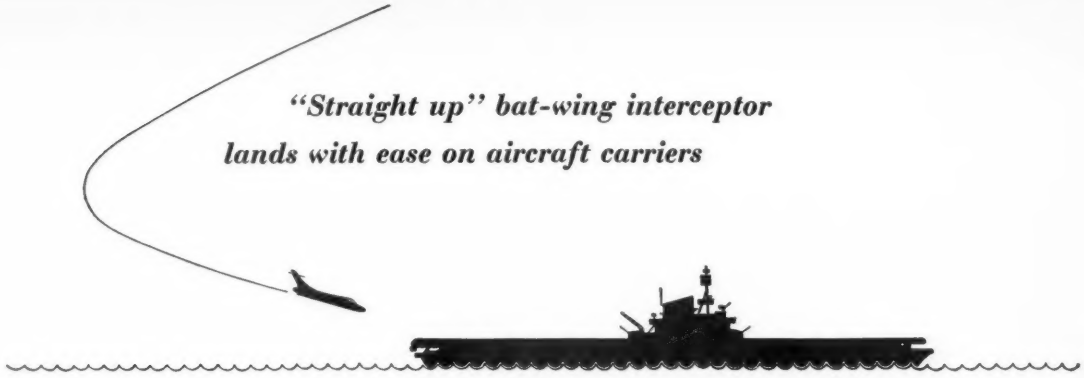

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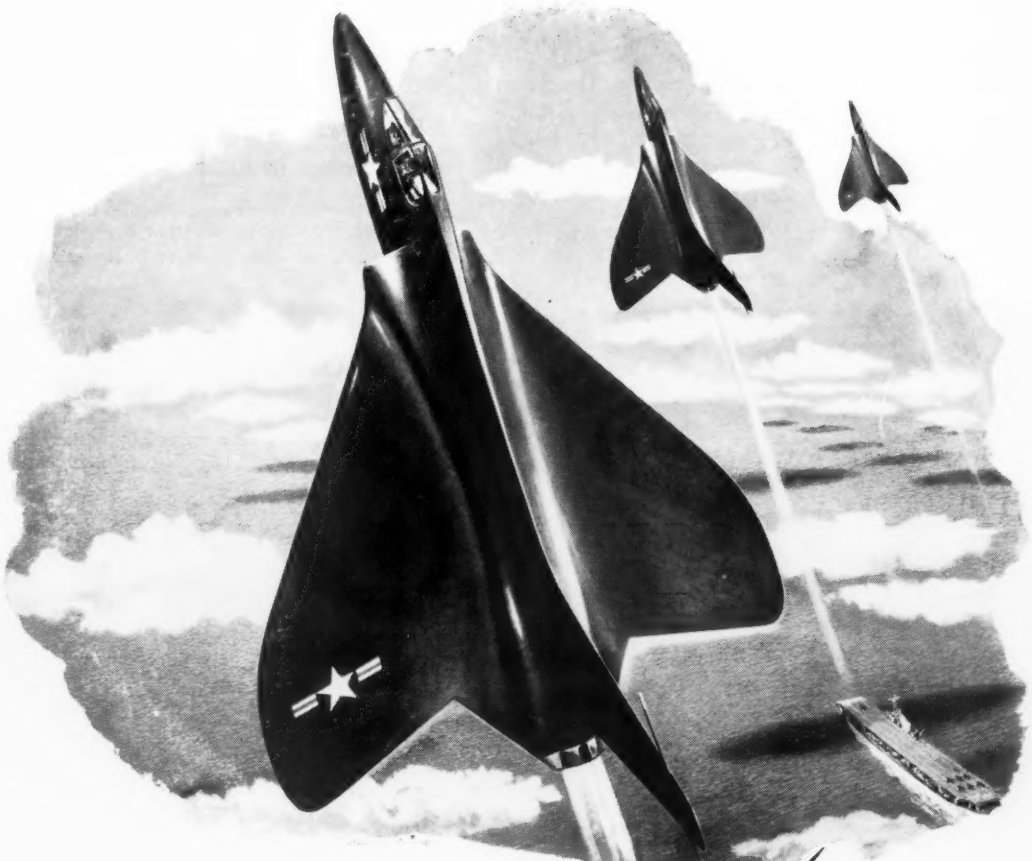

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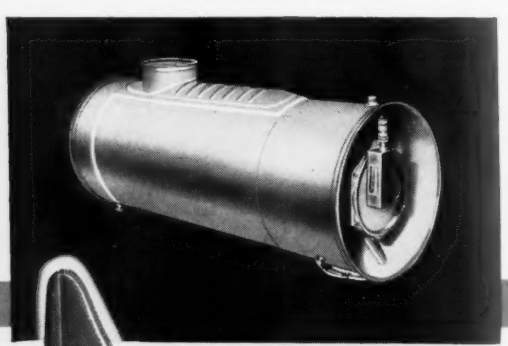

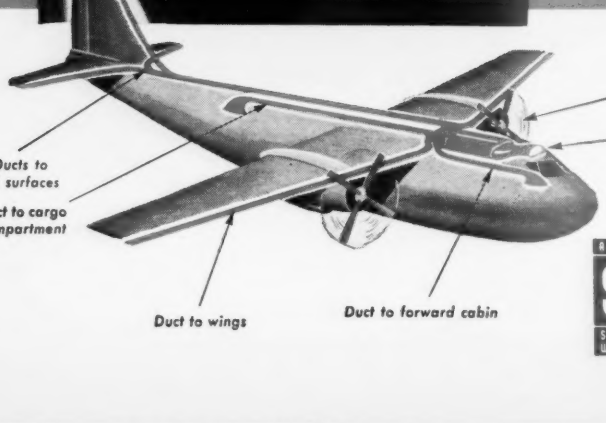
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Stainless Clad Steels. Helmut Thielsch. *Welding Journal, Research Supplement*, Vol. 31, No. 3, March, 1952, pp. 142-s–160-s, illus. 81 references. Review of available information on manufacturing methods, carbon diffusion, physical and mechanical properties, heat treatments, welding procedures and processes, dilution, selection of welding electrodes, and flame cutting.

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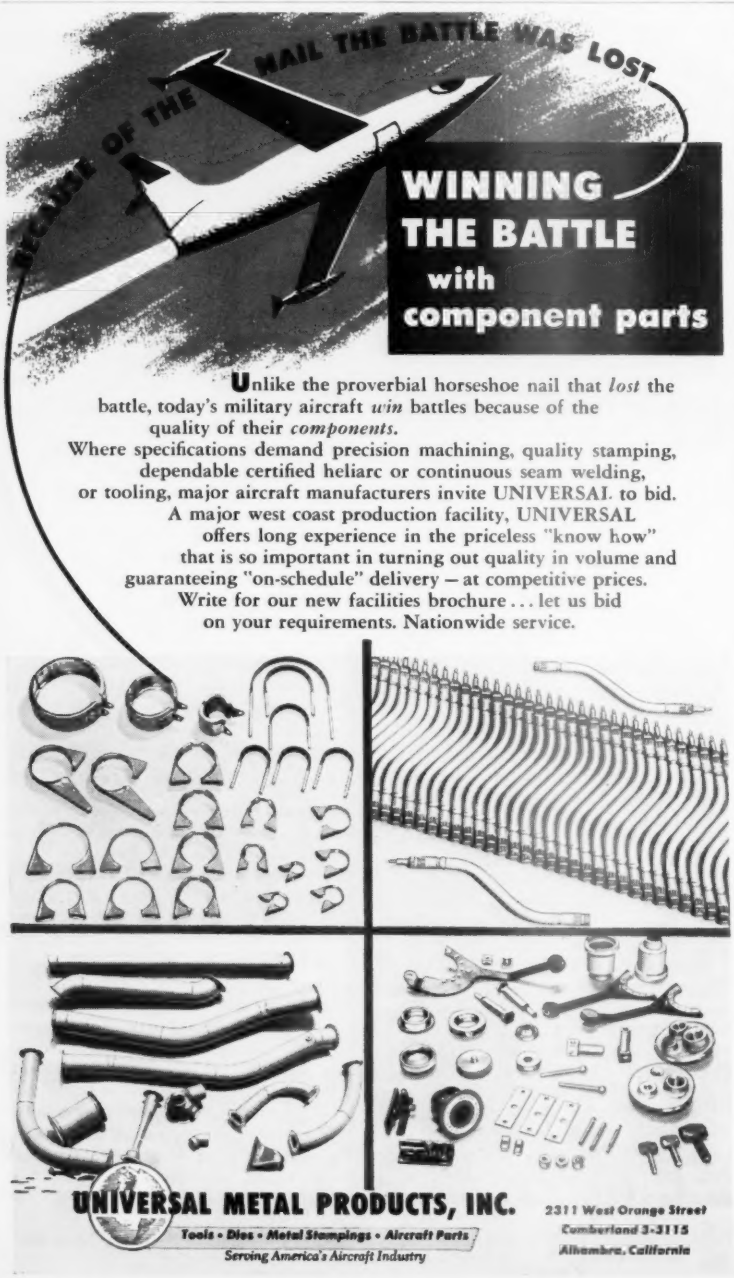
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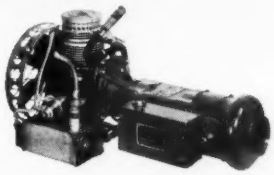
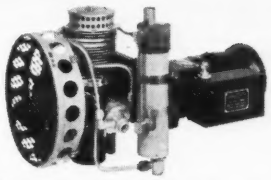
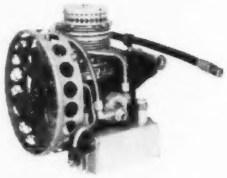
Airborne. 400 cycle — 208v AC drive. Horizontal sump.



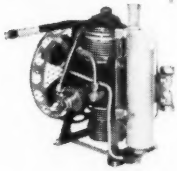
Airborne. 28v — 3½ hp motor. Horizontal sump. Radio noise suppressor.



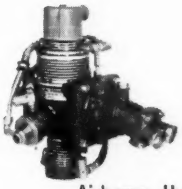
Airborne. 28v — 3½ hp motor. Vertical sump. Radio noise suppressor.



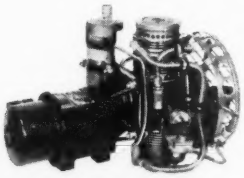
Airborne. Hydraulic drive. 1500 lb. hydraulic system. Horizontal sump.



Airborne. Hydraulic drive. 1500 lb. hydraulic system. Vertical sump. Pressurized inlet.



Airborne. Hydraulic drive. 3,000 lb. hydraulic system. Pressurized inlet. Remote sump.



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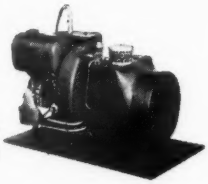
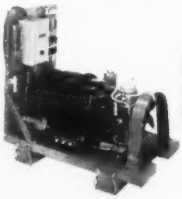
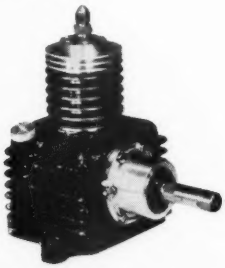


Ground application. Here a portable gasoline motor is used as a driving unit.



Ground application. Here the compressor can be driven by a 60 cycle 220 volt motor.



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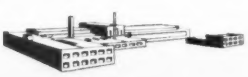

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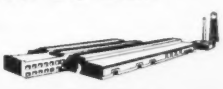

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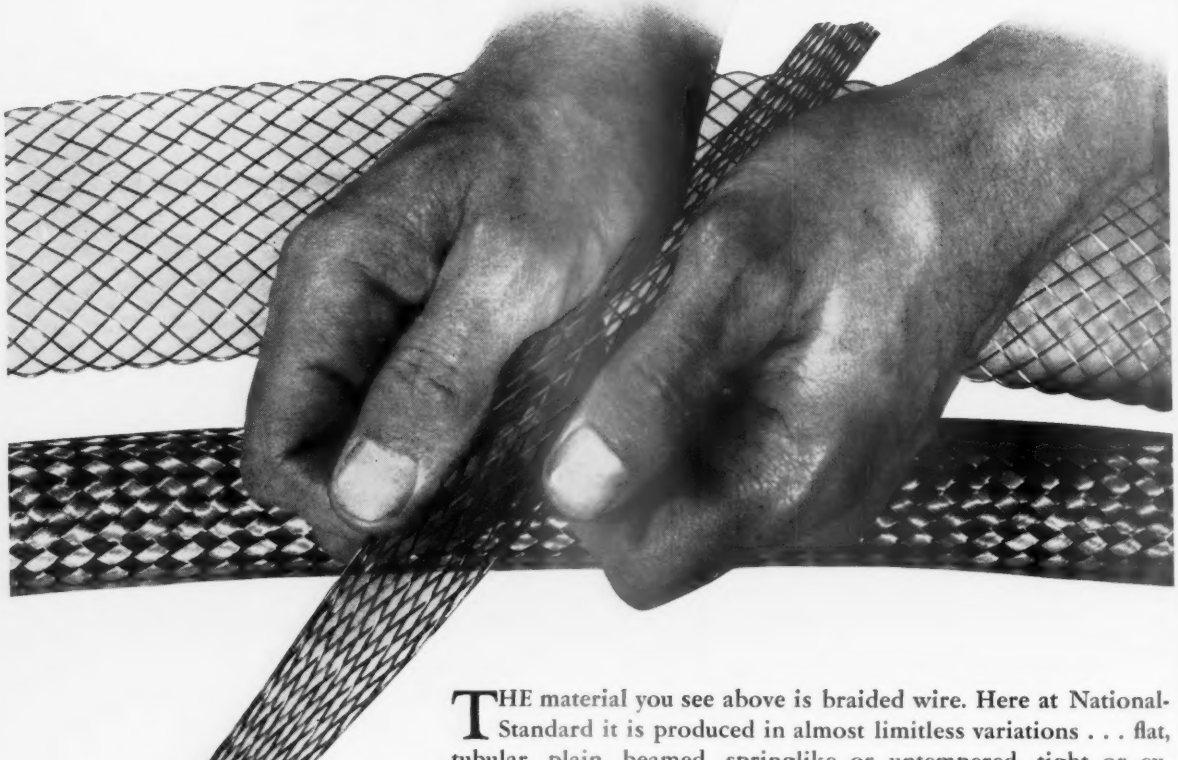

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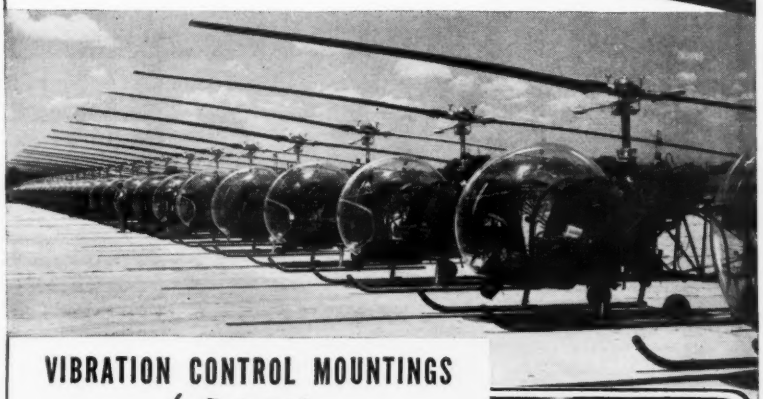

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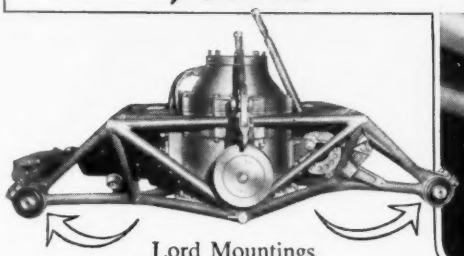

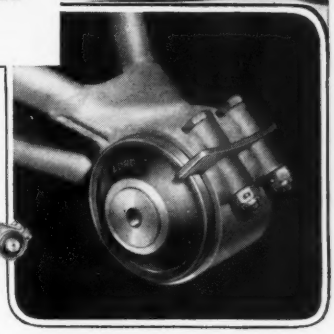

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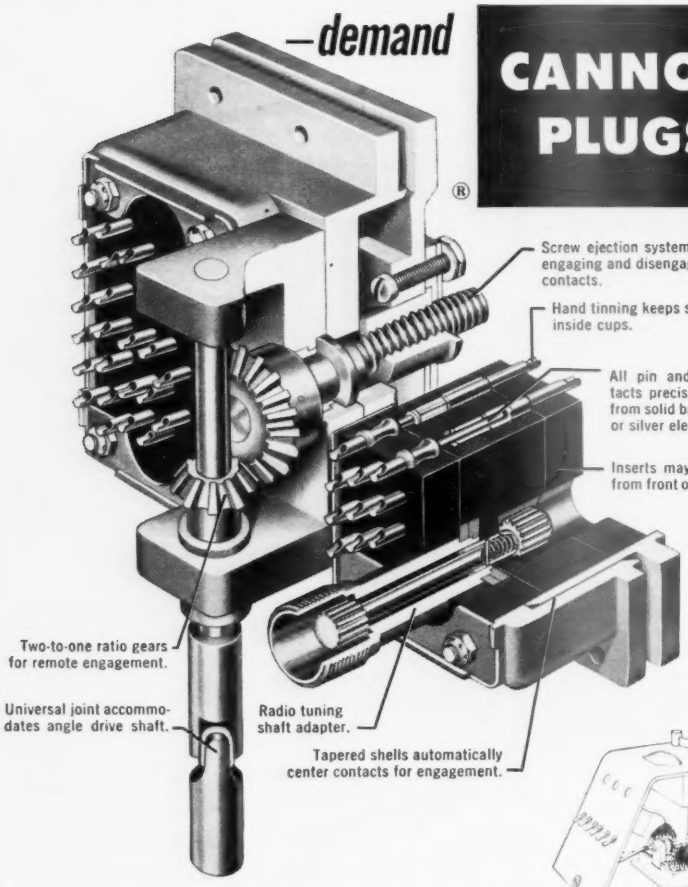
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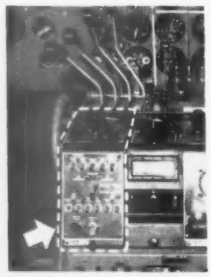

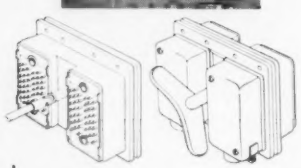

(Left) Same Cannon Plug without tuning shaft. Straight drive instead of 90° gear. (Right) Similar DPD2 with Dzus wing nut extraction method and junction shells. There are several other variations. Write for details.

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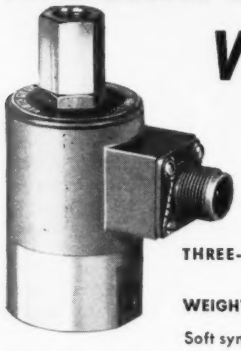

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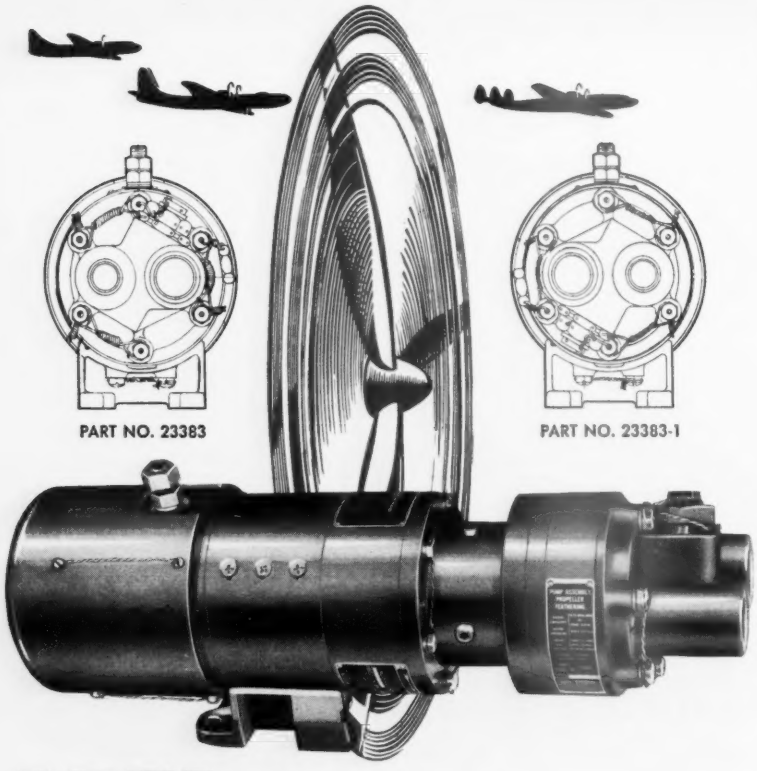

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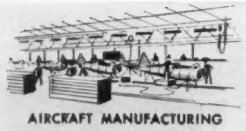

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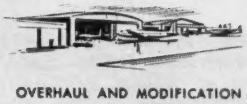

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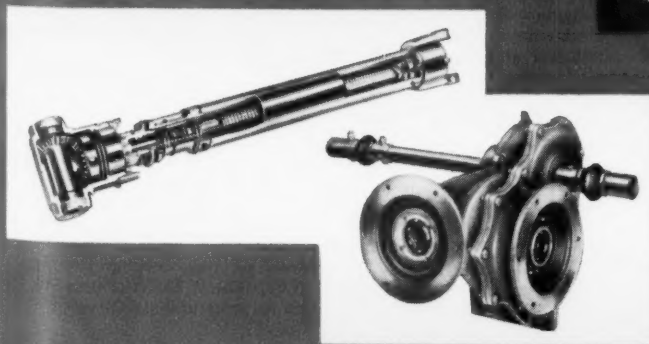

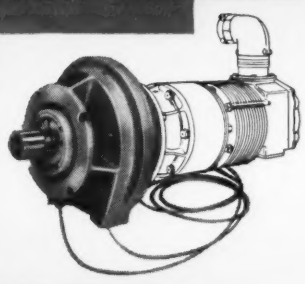

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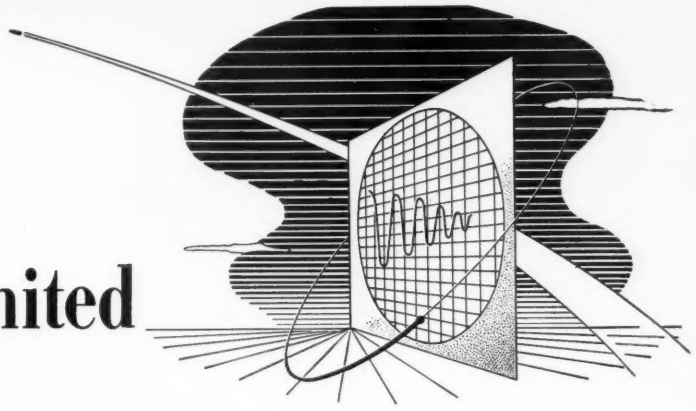

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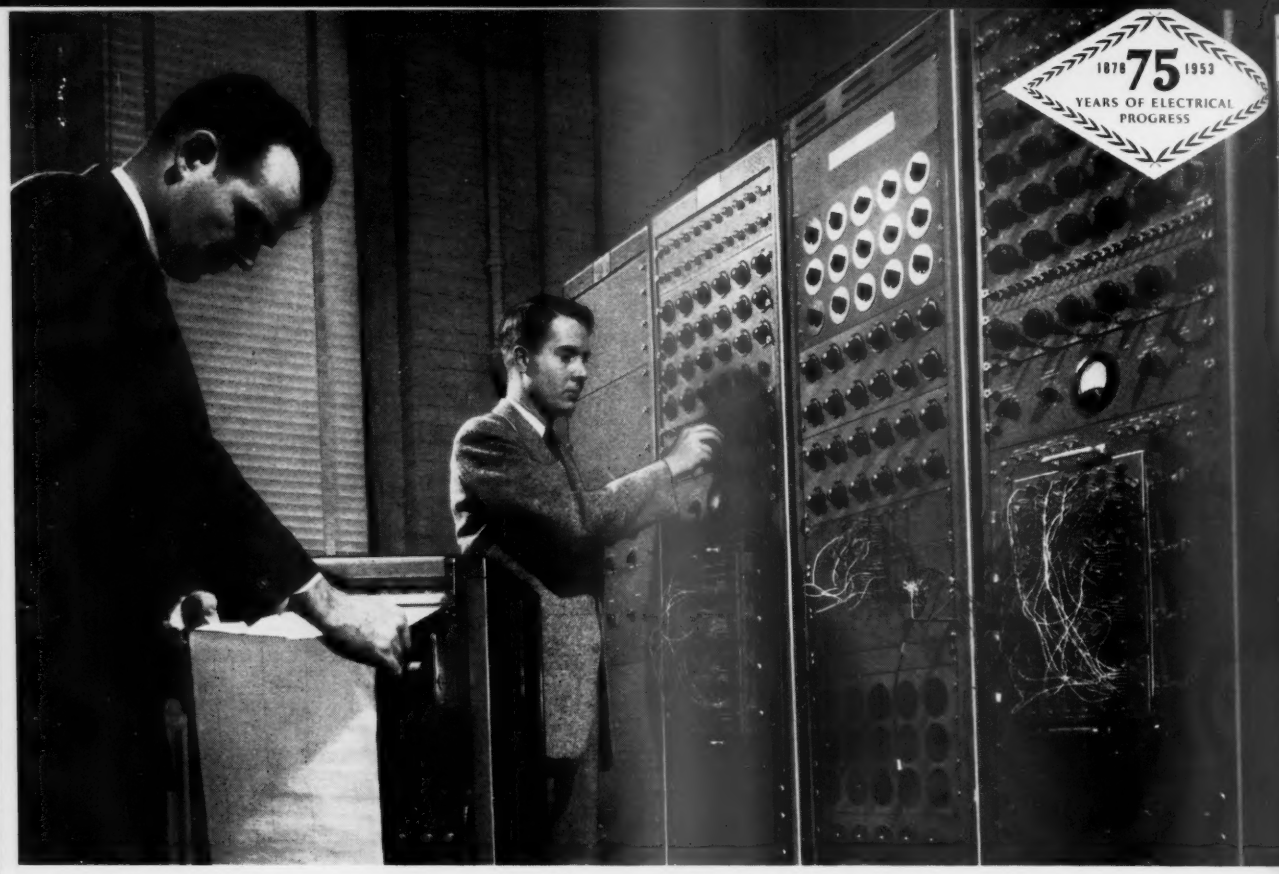

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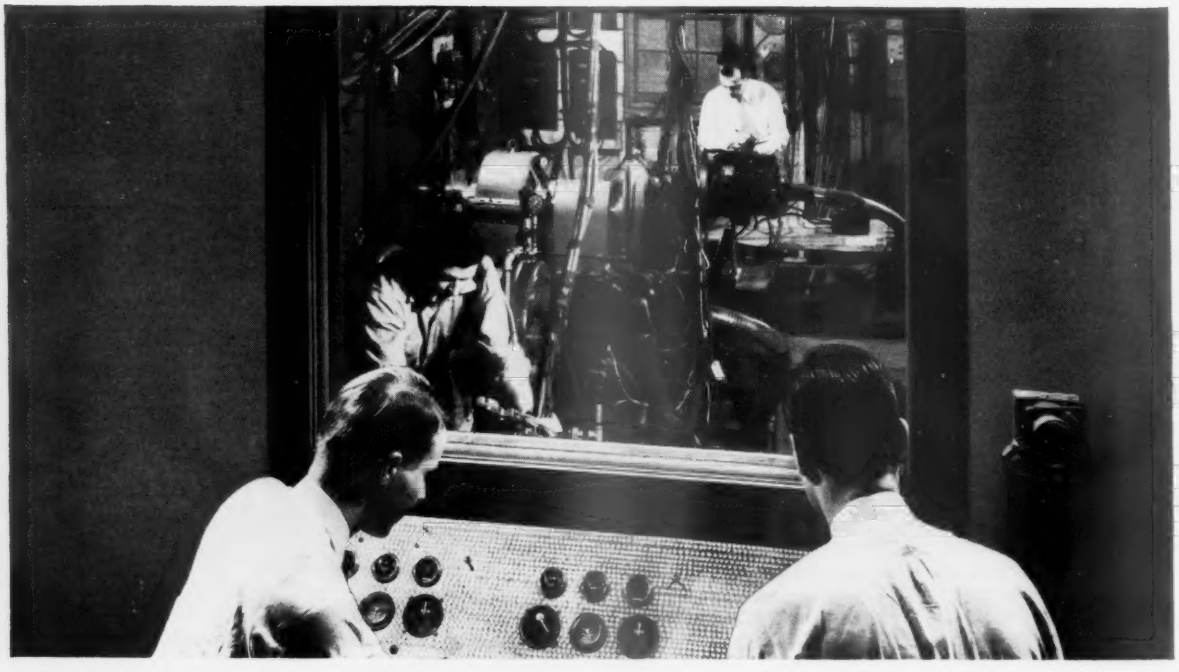

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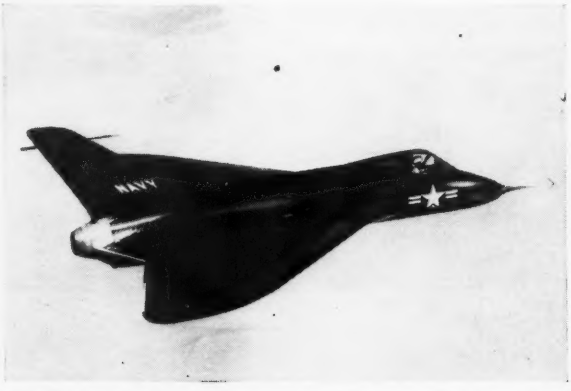

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Aeronautical Reviews — BOOKS

Wind-Tunnel Technique

By R. C. Pankhurst and D. W. Holder, London, Sir Isaac Pitman & Sons, Ltd.; New York, Pitman Publishing Corporation, 1952. 702 pp., figs. $10.

This treatise by two members of the staff of the National Physical Laboratory in England is an important and very welcome addition to aeronautical literature. The book presents a carefully written and detailed account of wind-tunnel design, construction, and operation for both development and research, together with a description of auxiliary apparatus and techniques. The material is arranged in twelve chapters followed by a number of appendixes. Chapter 1 gives a general introduction: the nomenclature, dimensionless coefficients, choice of axes, etc., are introduced, and the general purpose of experiments is briefly stressed. Chapter 2 deals with most phases of wind-tunnel design, for both low- and high-speed flow. Chapters 3 to 7 discuss the various techniques of measurement such as flow visualization methods, velocity measurements, balance systems, pressure measurements, and manometers. Chapters 8 and 9 take up wind-tunnel interference effects and the reduction of observations. Chapters 10 and 11 deal with "special measurements" and "experimental analogies" respectively. The more special and less frequently used methods and techniques of fluid flow investigations are given in these chapters. Finally, a chapter entitled "Notes on Models and Rigging" is included. The four appendixes include a variety of useful information such as tables of the more important functions of $1 - M^2$, and of the kinematic and dynamic viscosity of air. Losses for gauzes, pipes, etc., as well as the drag of struts, etc., are reviewed. French and German aerodynamic symbols are listed, and a date index of both the British Reports and Memoranda and the American Technical Reports is included.

Many different techniques and methods of observation are discussed. Still, the authors succeed in giving sufficient technical details of each set-up, in both the text and drawings, to make the book of real value to a reader interested in improving or extending his own techniques. The formulas in the text are derived or references are given. The book is thus reasonably self-contained. Mathematics is kept to a minimum.

In writing a book on an experimental field involving a great many different techniques, it is obviously impossible to satisfy completely the specialists in these different techniques. Thus, for example, a hot-wire expert will feel that the discussion of hot-wire anemometry does not include the more recent developments in this field; similarly, a specialist in high-speed wind-tunnel work will feel that the discussion of supersonic diffuser efficiencies should be extended and deepened. The same might be said of boundary-layer measurements by an expert in this field. This possible criticism does not, however, reduce the value of the book much, if at all. The authors have certainly succeeded in presenting a coherent, well-arranged treatise on wind-tunnel techniques which, without doubt, fills a real need. Printing, figures, etc., are of high quality. The unusually long delay between the completion of the manuscript and the final appearance of the book is noticeable in the list of references and in some experimental results—e.g., wind-tunnel power requirements—but it by no means detracts from the value of the book.

The reviewer feels strongly that experimental research in aerodynamics is often hampered by unnecessary limitations in the techniques of experimenters. The *Wind-Tunnel Technique* of Pankhurst and Holder can be expected to be of great help in improving this situation.

DR. H. W. LIEPMANN
California Institute of Technology

For information on I.A.S. Library Service Facilities, see page 84

Statements and opinions expressed in Book Reviews are to be understood as individual expressions and not necessarily those of the Institute.

Heat Transfer Phenomena

By R. C. L. Bosworth. New York, John Wiley & Sons, Inc., 1952. 211 pp., figs. $6.00.

Dr. R. C. L. Bosworth, a distinguished Australian professor and authority on heat transfer, has consolidated the knowledge of many years of experience into his first book, *Heat Transfer Phenomena*, which might be aptly subtitled "The Philosophy of the Flow of Heat." Thus, the author consistently stresses the physical aspects of the problem in a manner that establishes his book as a unique treatise.

Heat Transfer Phenomena is eminently suited as a reference book to be used as a supplement to such complete and detailed works as that of Jakob in the field of conventional problems and that of Eckert for the formulation of heat and mass transfer problems. Indeed, the reviewer feels that the subject book is required reading for those teachers and industrial researchers who wish to broaden their knowledge of heat transfer.

Successful utilization of *Heat Transfer Phenomena* presupposes mastery of a traditional heat-transfer background, plus familiarity with applied physics, thermodynamics, chemistry, and statistics. Its use is limited, therefore, to the graduate student and technologists. Once this is acknowledged, the reader will find that, in addition to the excellence of the context, the listed symbology, the topic and author indexes, and the many references and bibliographies combine to produce a highly informative source. Moreover, the book is well written, clearly understandable, and excellently edited. It should be noted that no problems are included.

Before discussing *Heat Transfer Phenomena* in more detail, it might be well to quote the author in order to see, through his eyes, the justification of his effort and his resulting method of attack:

"As compared with the flow of electricity, the flow of heat is slow and cumbersome and there are no simple experimental means for restraining the flow along well defined channels. Consequently experimentalists in search of an easy path to academic distinction have tended

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to avoid this subject as unwieldy and unprofitable."

To partially circumvent this natural disadvantage, Dr. Bosworth departs from the usual compartmentalization of the various modes of heat transfer, and treats the flow of heat as an example of a transport process in which one or more physical characteristics of a molecular assembly may be transferred from point to point by the movement of certain "carriers." He deals initially with the properties of this class of phenomena and then shows how these properties are affected by such parameters as the number of individual units responsible for transport and the velocity and geometry of the paths traced by these units. Within this framework, the classical subdivisions of heat transfer may then be treated as particular applications of the general transport problem. By embracing this concept, the author has enabled himself to illustrate strikingly how analogies and similarities with better known flow phenomena can be conceived.

The chapters of *Heat Transfer Phenomena* have the following titles:

(I) A Classification of Transfer Processes
(II) The Thermal Conductivity of Gases
(III) Thermal Radiation
(IV) Thermal Conductivity in Condensed Phases
(V) Natural Convection
(VI) Forced Convection or the Simultaneous Transport of Heat and Momentum
(VII) The Simultaneous Transport of Heat and Mass
(VIII) The Use of the Equivalent Electrical Circuit
(IX) Thermodynamical Similarity

Of these, Chapters IV, VII, VIII, and IX are of unusual interest.

Throughout the book, the author notes where existing theory is weak or unknown, and why this is so. In particular, he cites the lack of knowledge on the thermal conductivity of liquids due to the inherent experimental difficulties of eliminating convection currents. In like manner, he sees the need for a definitive kinetic theory of liquids corresponding to that of gases, and, while discoursing on forced convection, he notes, with concern, systems that are mathematically intractable.

In many cases, Dr. Bosworth's lucid explanations add greatly to known theory. His interpretation of the Nusselt, Grashof, and Prandtl Numbers gives a definite physical significance to these quantities. Moreover, his demonstration of the place of inductive circuits in heat-transfer circuit analogs, his definition of the thermal Ohm, Farad, and Henry, and his discussion on the possibilities of unstable and resonating circuits appear to be personal advances.

In summary, R. C. L. Bosworth's attitude concerning the place of his book among the scientific literature seems to be thus:

There are available a number of excellent texts wherein the majority of conventional heat-transfer problems are documented. However, when you are faced with an unusual and complicated problem, see *Heat Transfer Phenomena* first. It will not give you a working formula or empiricism, but it will get your thinking on the right track; it will tell you what parameters must be included; and it will indicate whether similar work has been done.

In this evaluation, the reviewer concurs.

Dr. R. F. Brodsky
Supervisor
Theoretical Aerodynamics
Sandia Corporation

Aircraft Instrument Design

By W. H. Coulthard. New York, Pitman Publishing Corporation, 1952. 309 pp., figs. $7.50.

Sections on the theory of pilot's, navigator's, flight engineer's, and automatic-flight instruments cover the subjects in a logical, interesting fashion. Radio, celestial, and automatic dead-reckoning equipment for navigation are explained in sufficient detail to give the reader a working knowledge of each. The basic equations of aircraft stability and how they are coped with in automatic-pilot design are covered in a remarkably understandable manner.

Especially commendable is the section on pilot's instruments which discusses thoroughly, in an easily understandable manner, the complete theory as well as the mechanical design of these instruments. Fundamental information is given on the pressure-operated instruments indicating altitude, speed, and Mach Number, as well as on the pitotstatic system from which they operate. The discussions of errors in these instruments with typical empirical data should be of particular value to engineers of aircraft and missile computer systems.

The British-made instruments on which the mechanical descriptions are based closely resemble American counterparts, except for the radio navigation and electrical remote indicating systems.

It is evident that Mr. Coulthard and his collaborators, all authorities in the field, have written this book chiefly for engineers in the aviation industry. However, the mathematical formulas and derivations are simply but adequately written and are accompanied by tables, graphs, diagrams and illustrations which should make it a good textbook on the subject.

John H. Andresen, Jr.
Chief, Electro Mechanical Section
Kollsman Instrument Corporation

Book Notes

AIR TRANSPORTATION

Domestic Air Freight Origin-Destination Survey, 1950, Statistical Report. New York, Aviation Department, The Port of New York Authority, December, 1952. 153 pp., maps.

The on-line and interline air freight originating and terminating at New York Region Airports was abstracted from the respective airlines' waybill files for 1950 on a 50 per cent random sampling basis. To eliminate duplication, the interline freight transferred between carriers at the New York Region Airports was abstracted from the files of the carriers delivering the freight at these airports. Where waybill files were available in the New York area, Port Authority personnel was employed to abstract the necessary information. In most instances, where these files were not available locally, the carriers concerned offered the services of their air cargo accounting personnel and furnished us with the requested data.

AIRPLANE DESIGN

Aeronautical Engineering for National Certificate. Vol. 1. R. Tatham. London, The English Universities Press, Ltd., 1949. 173 pp., illus., diagrs. 10*s.* 6*d.*

This first volume is intended to contain sufficient information to enable the student to cover the major aeronautical subjects of aerodynamics and aircraft structures and design to the standard required for the S2 and S3 courses for the Ordinary National Certificate or the first year of a three-year full-time course for a Higher National Diploma. Although a certain amount of the theory of strength of materials has been included, no attempt has been made to present a comprehensive treatment of this and any other subject, such as mechanics and metallurgy. No avoidance of elementary calculus has been attempted. Following the usual syllabus for National Certificate, the amount of aerodynamics contained in this volume is small and of an elementary nature. Subsequent volumes, however, are to extend the major subjects to the standard required for the Higher National Certificate. For the convenience of the student, the main principles of mechanics required are given in an appendix, and a few examples to be worked by the student have been added to most chapters. The author is Senior Lecturer in the Department of Aeronautical Engineering, Loughborough College.

REFERENCE WORKS

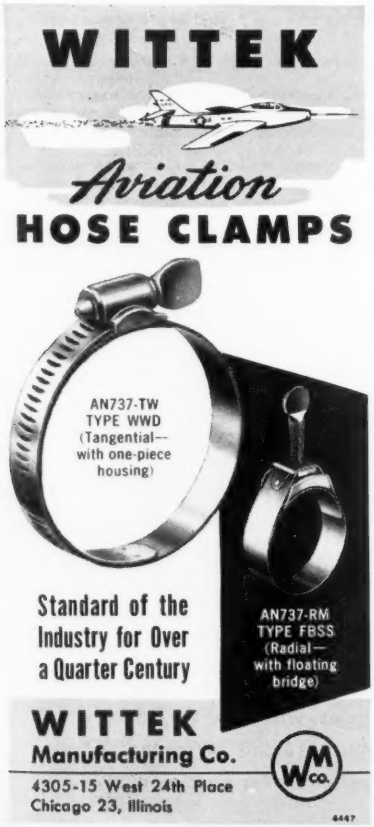
Jane's All the World's Aircraft, 1952-53. Compiled and Edited by Leonard Bridgman. New York, McGraw-Hill Book Company, Inc., 1952. 324 pp., illus., diagrs. $22.50.

A new feature, which will enable quick reference to be made to specifications and illustrations of aircraft not now in production but still in service, is the inclusion in both the general aircraft index and the helicopter index of references to all aircraft described in the six preceding editions (1945–46, 1947, 1948, 1949–50, 1950–51, 1951–52) going back to the end of the war. In this edition, the pages are numbered consecutively throughout, and all index material is grouped together at the end of the volume. What were formerly Parts A, Military Aviation, and B, Civil Aviation, have been considerably modified in presentation. The military section now consists of the markings of the air forces of the world. The civil aviation sections contain the international civil aircraft markings, descriptions of the international aviation organizations, and, in tabular form, data on the world's air lines. Then follow the descriptive and illustration sections on airplanes (including helicopters and gliders), gas-turbine engines, piston engines, and airships. Although publishing economy compelled some reduction in the overall size of the edition, the present volume maintains the high standard of earlier editions in its specifications and illustrations of aircraft and power plants. Its value as a reference tool is augmented by the inclusion of the seven-volume index.

THERMODYNAMICS

Proceedings of the General Discussion on Heat Transfer, 11th–13th September, 1951. London, Institution of Mechanical Engineers; New York, American Society of Mechanical Engineers, 1951. 496 pp., illus., diagrs., figs. $10.

This discussion was arranged by the I.M.E. and the A.S.M.E. with the object of reviewing developments in the knowledge of the principles of the transference of heat and in the design of apparatus making use of such knowledge which have taken place during the period 1940–50. Among the 54 societies participating were the Institute of the Aeronautical Sciences and the Royal Aeronautical Society. Ninety-three papers were presented, on the following main topics: (a) heat transfer with change of state; (b) heat transfer between fluids and surfaces; (c) conduction in solids and fluids; (d) radiation, instrumentation, measurement technique, and analogies; and (e) special problems such as heat transfer in turbine blade cooling, in liquid metals, in gas turbines, and in piston engines, the mercury boiler, and so on. The present volume contains the texts and illustrations of the papers, transcripts of oral discussions, written communications, and authors' replies. There is a detailed index of the subject matter.



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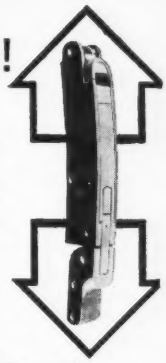

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Personnel Opportunities

This section is for the use of individual members of the Institute seeking new connections and organizations offering employment to Aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

Wanted

Engineers—Opportunities for employment in the Naval Aviation Program exist in the Bureau of Aeronautics, Department of the Navy, Washington, D.C. Professional engineers with experience in aerodynamics are wanted to fill civil service positions up to and including grade GS-11, $5,940 per annum. A professional engineer with experience in hydrodynamics and in Seaplane Towing Tank work is desired to fill a civil service position, grade GS-11, at $5,940 per annum. Applications may be submitted on Standard Form 57, Application for Federal Employment, to: The Department of the Navy, Bureau of Aeronautics, Personnel Division, Attention PE-22, Washington 25, D.C. The Standard Form 57 is available at U.S. Post Offices or may be obtained by writing to the Personnel Division, Bureau of Aeronautics. For additional details and information call or write to the Personnel Division, Bureau of Aeronautics. Visitors to the Washington area may call at Room 3909 of the Main Navy Building, 19th and Constitution Avenue, N.W.

Professors—The U.S.A.F. Institute of Technology has several vacancies for qualified professors or engineers to teach on a graduate and undergraduate level in aeronautical, mechanical, electrical, and production engineering and mathematics. Employment will be effected in accordance with Civil Service Regulations. Grade levels range from GS-9, $5,060 per annum to GS-13, $8,360 per annum. Applications should be made on Standard Form 57, available at any Post Office, or by letter to the Dean, Resident College, U.S.A.F. Institute of Technology, Wright-Patterson Air Force Base, Ohio.

Engineers—The U.S. Naval Air Rocket Test Station has several vacancies in the Engineering Department. **General Engineer,** GS-11, $5,940 per annum. Duties: Head of the Development Section, Instrument Branch, of the Power Plant Division. Supervises and participates in the design and modification of electronic, electrical, hydraulic, and mechanical instrumentation components to measure or record temperature, pressure, flow, velocity, and stresses encountered in the testing and evaluation of rocket engines and propellants. **Chemist,** GS-11, $5,940 per annum. Duties: As an assistant to the head of the Chemistry Branch of the Propellants Division, performs analyses on fuels, oxidizers, metals, plastics, etc. This will include determinations of the amounts and nature of impurities in these materials. These analyses will also include effects of these impurities upon viscosity, freezing point, and other relevant physical and chemical properties of the propellants or materials, etc. **Electronics Engineer,** GS-7, $4,205 per annum. Duties: As an engineer in the Installation Section, Instrument Branch, Power Plant Division, cooperates in the design of new instrumentation and modification of existing testing facilities. Performs experiments on instruments and allied equipment to ascertain characteristics of same. Supervise and participate in the calibration and test operation of all instrumentation on an assigned project. **Chemical Engineer,** GS-7, $4,205 per annum. Duties: As an engineer in the Special Projects Branch of the Propellants Division, evaluates various materials of construction and new methods of handling, storing, and transferring propellants. Performance of calculations related to rocket efficiency or properties of propellants. **Engineering Draftsman,** GS-6, $3,795 per annum. As a design draftsman in the design branch of the power-plant division, originates designs and layouts relating to the mechanical design of experimental rocket engines, rocket-engine accessories, and rocket-engine test facilities.

Applicants should complete Standard Form 57, Application for Federal Employment, which is available at any Post Office, and forward to the Industrial Relations Officer, Industrial Relations Department, U.S. Naval Air Rocket Test Station, Lake Denmark, Dover, N.J.

Engineers—The U.S. Naval Air Station, Alameda, Calif., announces the following openings. **Aeronautical Engineer** (Gen.), GS-9, $5,060. Investigates and prepares overhaul directives, correspondence, and reports on engineering problems pertaining to aircraft equipage and other items of air-borne equipment. **Mechanical Engineer,** GS-9, $5,060. Specifies facilities and designs mechanical equipment used in the overhaul and test of aircraft components and engines. **Electronic Engineer,** GS-9, $5,060. Specifies or designs electrical and electronic equipment used in the overhaul and test of aircraft components and engines. Applicants should submit Standard Form 57, Application for Federal Employment (available at any Post Office), to: Employment Superintendent, Industrial Relations Department, U.S. Naval Air Station, Alameda, Calif.

461. Senior Experimental Test Engineer—For a supervisory position in charge of the Jet Division Development Engineering Experimental Test Laboratory. The applicant must have a minimum of 5 years of experience as a supervisor in the mechanical laboratory testing field, preferably in direct connection with gas turbine components. He must be familiar with pressure, temperature, and vibrations measuring equipment and instrumentation; must be able to supervise the design and use of test equipment; should be able to evaluate performance characteristics and write reports. This man will be assisted by technicians and draftsmen.

457. Development Engineer—A large Cleveland manufacturer is now adding a jet-engine development laboratory and expanding its automotive engine research and development facilities. There are several openings for aeronautical and automotive engineers whose primary interest is engine development. We are not engine builders but have been active in the research and development of engine components and accessories. Make your reply complete.

The number preceding the notices represents the Box Number of the Institute of the Aeronautical Sciences to which inquiries should be addressed.

454. Professor—State university located in the East has an opening for a professor to teach internal combustion engines and related courses to mechanical and aeronautical engineering students. Excellent opportunity present to develop strong program in power-plant field. Kindly furnish personal data, educational background, and experience in initial reply.

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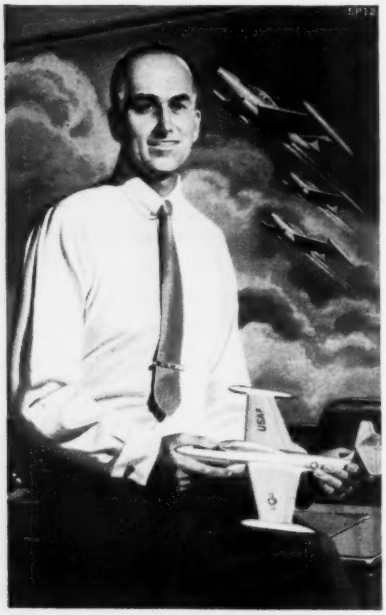
460. Mechanical-Aeronautical Engineer—B.S. in M.Ae.E., University of Maryland, 1949. Three years' experience with Peruvian Air Forces covering aircraft maintenance, general mechanics, and electrical engineering practice. Speaks and writes Spanish fluently. Actually living in Peru. Desires position that presents opportunity for advancement through merit. Prefers to initiate in research work in any branch of the aeronautical field. Age 32, married.

459. Engineer—Ph.D. Age 33. Wishes to work with computing group using high-speed computing machines. Background in aerodynamics, thermodynamics, heat transfer, mechanics, and applied mathematics. Limited experience with digital computers. Please send full particulars.

458. Aeromechanical Engineer—B.M.E. Age 34. Broad background in the aircraft industry including guided-missile electromechanical systems development, flight-test research, and stress analysis. Currently engaged as assistant project electromechanical engineer. Accomplishments include direction of missile electrical system design, booster rocket installation design, test equipment design, environmental test program, and flight-test programs. Seeking responsible position in missile, aircraft, or allied fields in greater New York City area only. Current salary, over $7,000. Résumé furnished on request.

455. Aeronautical Engineer and Aviation Executive—Young, aggressive, responsible, full of initiative, with 17 years' experience in the aviation industry. This experience includes 5 years at management level and 12 years of comprehensive engineering assignments. The management experience includes successful handling of sales (instruments and accessories); contract negotiation in specifications and financial; and contacts with all aircraft manufacturers, air lines, U.S.A.F. and BuAero, and some production. Engineering experience was particularly demanding in stress analysis, airplane structural design, testing, aerodynamics, and supervision. This covers participation in eleven complete aircraft projects and approximately 39 others of a preliminary or partial nature either as a project engineer, project stress and structural engineer, or senior engineer. Familiar by contact and execution with all departments and divisions of aircraft design, production, procurement, and sales. University graduate, Who's Who in Engineering, Who's Who in Aviation, registered professional engineer, certificated private pilot. Desires interview with responsible companies seeking top-level management personnel to handle engineering, sales engineering, aviation division, or equivalent.



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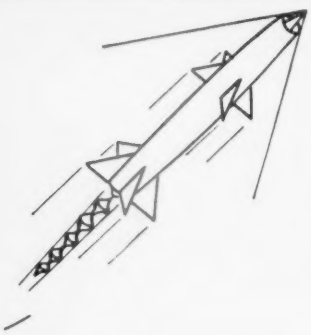

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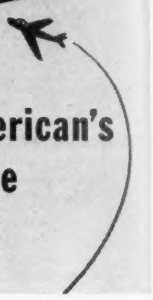

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453. Aeronautical Engineer—B.S., M.S. in Aero. Engrg. Nine years' experience in structures, aerodynamics, dynamic analysis, and manufacturing. Papers published. At present, project engineer directing dynamic analysis of a missile. Interested in staff or administrative position in missile engineering, level commensurate with salary over $10,000. Detailed professional history given only on receipt of letter describing specific position.

452. Flutter and Vibration Engineer—B.Ae., M.Ae.E. Age 28. Four years of diversified experience in the fields of vibration and flutter, including allied instrumentation with one of the largest air-frame manufacturers on the East Coast. Desires stimulating position requiring ingenuity and imagination. Interested in research and development work with progressive concern or a position as senior vibrations engineer in a supervisory capacity. Also interested in becoming a partner or active member in an associated private business venture and willing to invest small sum of money. East Coast location preferred but will relocate if salary is right.

451. Aeromechanical Engineer—Five years of college, B.S.E. Two years of junior design and production-design liaison; 6 months hydraulic servos. Former bomber-transport pilot. Desires a responsible position as a development, sales-service, field, or junior project engineer. Prefers a small eastern company. Will consider all inquiries.

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